WORK PLAN

FOR WATERSHED PROTECTION, FLOOD PREVENTION, AND RECREATION

FLAT ROCK CREEK WATERSHED

Crawford County, Arkansas

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

ADDENDUM
January 1975

FLAT ROCK CREEK WATERSHED

CRAWFORD COUNTY
ARKANSAS

INTRODUCTION

FLAT ROCK CREEK WATERSHED
ARKANSAS

This addendum is based on the Water Resources Council's Principles and Standards for Planning.

Effects resulting from the selected work plan alternative are displayed under separate accounts for National Economic Development, Environmental Quality, Regional Development, and Social Well-Being.

The abridged environmental quality plan has been developed by an interdisciplinary team using information and data assembled during investigations and analysis of the Flat Rock Creek Watershed work plan.

January 1975

FLAT ROCK CREEK WATERSHED
ARKANSAS

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This addendum shows project cost based on 1974 price base for construction costs amortized for 100 years at 5 7/8 percent interest.

Benefits for this addendum are based on current normalized prices for agricultural commodities and 1974 prices for other items.

Annual project benefits, cost, and benefit-cost ratios are as follows:

Total Benefits	$365,000
Total Costs	$262,000
Benefit-Cost Ratio	1.4:1
Benefit-Cost Ratio Without Secondary Benefits	1.1:1

January 1975

SELECTED ALTERNATIVE

NATIONAL ECONOMIC DEVELOPMENT ACCOUNT

FLAT ROCK CREEK WATERSHED
ARKANSAS

Components	Measures of effects 1/ (dollars)
Beneficial effects:	
A. The value to users of increased output of goods and services	
1. Flood prevention	256,990
2. Recreation	10,350
3. Utilization of unemployed and underemployed labor resources	
Project construction and OM&R	16,000
Induced activities	8,700
Total beneficial effects	292,040

Components	Measures of effects 1/ (dollars)
Adverse effects:	
A. The value of resources required for a plan.	
1. Flood retarding structures and channels.	
Project installation (structural measures)	228,000
Project administration	32,590
OM&R	1,400
Total adverse effects	261,990
Net beneficial effects	30,050

1/ Average annual at 5-7/8 percent for 100 years.

SELECTED ALTERNATIVE

ENVIRONMENTAL QUALITY ACCOUNT

FLAT ROCK CREEK WATERSHED
ARKANSAS

Components	Measures of effects
Beneficial and adverse effects:	
A. Areas of natural beauty.	1. Flood reduction benefits will allow the owners of 30 farms, 16 commercial properties, 4 industrial properties, and 147 residential properties to improve the physical appearance of their houses, yards, lots, grounds, and surroundings.
	2. An unsightly ditch through Van Buren will be improved and landscaped.
	3. Open water will add beauty to the Van Buren City Park.
	4. Reduction of sediment yield to 7.5 acre-feet per year will extend the life expectancy of Hollis Lake about 40 years.
B. Quality considerations of water, land, and air resources.	1. Sheet erosion will be reduced 32 percent to an average annual rate of 1.5 tons per acre.
	2. Lesser amounts of pesticides and agricultural chemicals in the surface water will result from the reduction of flooding and erosion.

	3. The elimination of stagnant, unsanitary pools in Town Branch will improve the quality of water discharged.
	4. Air and water pollution will be increased slightly during project construction.
C. Biological resources and selected ecosystems.	1. The 25 farm ponds to be built will provide additional fishing and recreational resources to local residents.
	2. The ungated orifice in Structure Number 2 will prolong flows in Flat Rock Creek and stabilize habitat for fish such as riffle darters and stonerollers as well as insure a continual level of dissolved oxygen within the pools.
	3. During construction, the fishery habitat will be temporarily disturbed but it will recover when construction is complete.
	4. About 42 acres of still, warmwater, sport fishery will be created.
D. Historical, archeological, and geological.	1. Some land treatment or management practices such as land leveling for irrigation or deep plowing may damage or destroy archeological values.
	2. The detailed archeological survey of the construction areas may identify archeological values that can be salvaged or preserved.

E. Irreversible or irretrievable commitments.

1. About 32 acres of cropland, 19 acres of woodland, and 17 acres of urban land will be converted to embankments, emergency spillways, and permanent pools.

2. Any archeological values that are inadvertently disturbed by construction will be partially or completely irretrievably lost. Any salvage operations will preserve the data obtained but the site values and any unobtained data will be a committed non-renewable resource of the project.

SELECTED ALTERNATIVE

REGIONAL DEVELOPMENT ACCOUNT

FLAT ROCK CREEK WATERSHED
ARKANSAS

Components	Measures of effects 1/ State of Arkansas	Rest of Nation
	- - - dollars - - -	
A. Income		
Beneficial effects:		
1. The value to users of increased output of goods and services		
a. Flood prevention	256,990	-
b. Recreation	10,350	
c. Utilization regional unemployed or under-employed labor resources		
Project construction and OM&R	16,000	-
Induced activities	8,700	
d. Secondary	72,870	-
Total beneficial effects	364,910	-

Components	Measures of effects 1/ State of Arkansas	Rest of Nation
	- - - dollars - - -	
A. Income		
Adverse effects:		
1. The value of resources contributed from within the region to achieve the outputs		
a. Floodwater retarding structures and channels		
Project installation (structural measures).	48,350	179,650
Project administration	1,290	31,300
OM&R	1,400	0
Total adverse effects	51,040	210,950
Net beneficial effects	313,870	-210,950

1/ Average annual at 5-7/8 percent for 100 years.

SELECTED ALTERNATIVE

REGIONAL DEVELOPMENT ACCOUNT (Continued)

FLAT ROCK CREEK WATERSHED
ARKANSAS

Components	Measures of effects: State of Arkansas	Measures of effects: Rest of Nation
B. Employment		
Beneficial effects:		
1. Increase in number and types of jobs		
a. Agricultural employment	Utilization of 5 permanent semi-skilled man-years of employment in agricultural production	-
b. Employment for project construction	80 semi-skilled jobs for 5 years	-
c. Employment for project OM&R	0.3 permanent semi-skilled jobs	-
d. Employment in induced activities	90 permanent semi-skilled jobs	-
Total beneficial effects	80 semi-skilled jobs for 5 years	-
	95.3 permanent semi-skilled jobs	-

Components	Measures of effects: State of Arkansas	Measures of effects: Rest of Nation
B. Employment		
Adverse effects:		
1. Decrease in number and types of jobs		
a. Loss in agricultural employment in project take area	0.3 permanent semi-skilled jobs	-
Total adverse effects	0.3 permanent semi-skilled jobs	-
Net beneficial effects	80 semi-skilled jobs for 5 years	-
	95 permanent semi-skilled jobs	-

SELECTED ALTERNATIVE

REGIONAL DEVELOPMENT ACCOUNT (Continued)

FLAT ROCK CREEK WATERSHED
ARKANSAS

Components	State of Arkansas	Measures of effects	Rest of Nation
C. Population Distribution			
Beneficial effects:	Creates 80 semi-skilled jobs for 5 years. Creates 95 permanent semi-skilled jobs. Population of Crawford County increased 20 percent from 1960 to 1970.		-
Adverse effects:			
D. Regional economic base and stability	-		-
Beneficial effects:	Provides a 99 percent reduction in average annual damages to urban property in Van Buren. Provides a 74 percent reduction in average annual damage to agricultural property. Flood protection is an integral part of the success of other programs which are underway for the economic development of the area. The project will create 80 semi-skilled jobs during the construction period. Also, 95 new permanent semi-skilled jobs associated with basic and derivative industries will continue after project construction periods. Van Buren has an unemployment rate of 10.8 percent. Crawford County is eligible to receive assistance under the Public Works and Economic Development Act of 1965 in the form of grants and small business loans.		-

SELECTED ALTERNATIVE

SOCIAL WELL-BEING ACCOUNT

FLAT ROCK CREEK WATERSHED
ARKANSAS

Components	Measures of effects
Beneficial and adverse effects:	
A. Real income distribution	1. Creates a net of 175 low to medium income jobs for area residents. There will be 95 permanent semi-skilled jobs. There will be 80 skilled jobs for 5 years.
	2. Create regional income benefit distribution of $364,910 by income class as follows:

Income Class (dollars)	Percentage of Adjusted Gross Income in Class	Percentage of Benefits in Class
Less than 3,000	20	20
3,000-10,000	62	50
More than 10,000	18	30

SELECTED ALTERNATIVE

SOCIAL WELL-BEING ACCOUNT (Continued)

FLAT ROCK CREEK WATERSHED
ARKANSAS

Components	Measures of effects
	3. Local costs to be borne by region total $51,040 with distribution by income class as follows:

Income Class (dollars)	Percentage of Adjusted Gross Income in Class	Percentage of Contribution in Class
Less than 3,000	20	16
3,000-10,000	62	72
More than 10,000	18	12

. Life, health, and safety	1. Provide a 99 percent level of flood protection to a 62 acre urban area in Van Buren. This area contains 16 commercial properties, 4 industrial properties, and 147 residential properties. Future threats of loss of life and displacements during floods will be eliminated. Provide a 74 percent reduction in average annual damages on 968 acres of agricultural flood plain which contains 30 farms. Agricultural flood plain lands is valued at about $500 per acre. The present value of undeveloped urban land is about $2,000 per acre.
. Recreational opportunities	1. Creates 10,350 recreational days annually for citizens of Arkansas and visitors.

FLAT ROCK CREEK WATERSHED
Crawford County, Arkansas

ENVIRONMENTAL QUALITY PLAN
(Abridged)

A. Environmental Quality Problems and Component Needs

Urban flooding in the watershed causes damages to industrial, commercial and residential properties. This causes direct environmental degradation to lawns, gardens, and surroundings and indirectly requires further exploitation of minerals, wood products, and plastics and the energy to process these for replacement of items such as building materials, machinery, and appliances. Vector problems increase following urban flooding. Soil erosion is degrading the land, plant, and animal resources of the watershed, particularly in the upland part. Soil erosion that causes sediment yield to Hollis Lake is polluting the waters in the lake and is resulting in a short life expectancy of the lake and surrounding wetland habitat. Town Branch is an ephemeral, polluted stream that receives waste from food-processing plants. The waste collects in small pools and causes unsanitary conditions. The major problem of the Flat Rock Creek fishery is the lack of running water and low oxygen levels in the pools during the dry periods of the year. There is a lack of water-based recreational opportunities and visual diversity of landscape in the watershed, especially in the City Park. The upland part of the watershed is deficient in areas that are managed specificially for wildlife. An open rock quarry is degrading the natural beauty of the part of the watershed where it is visible.

The environmental quality component needs of the watershed are the preservation of land, plant, and animal resources; the reduction of flooding; the improvement of the fishery in Flat Rock Creek, the abatement of pollution in Town Branch; the enhancement of upland wildlife habitat; the preservation of wetland wildlife habitat; and the improvement of the visual appearance of a rock quarry.

B. Description of Plan Elements, Costs, and Implementation

Conservation land treatment measures would be accelerated over the entire watershed and most of the land would receive treatment. At the end of the installation period, complete treatment would be accomplished on 2,850 acres of cropland, 4,500 acres of grassland and 3,100 acres of forest land. Two dams would be built for flood control and one of these would include storage for recreational purposes. One structure would provide for low-flow augmentation in Flat Rock Creek. About 1.7 miles of channel in Van Buren would be concrete-lined. Work on Flat Rock Creek would consist of clearing and debris removal from the existing channel. Wildlife habitat management would

be planned for 230 acres to improve the cover conditions and to increase food supplies for upland game. Also the revegetation of dams, spillways, and other areas disturbed by construction would include woody and herbaceous plants for landscaping and wildlife habitat. Wildlife wetland management would be planned for 650 acres. Waste disposal from the food-processing plants could be suspended by voluntary efforts and costs by the companies or by city ordinance. The visual appearance of the rock quarry could be improved by screening with tall growing vegetation and partial back-filling for reclamation.

Archeological values in the watershed would be protected by co-operative agreement between the Arkansas Archeological Survey and the Soil Conservation Service. The Survey would determine and appraise resources, evaluate impacts, recommend mitigation, and perform any needed salvage.

The total cost of the project is estimated to be $4,678,710 of which $3,609,671 would be from PL-566 funds and $1,069,039 from other funds. The project would be implemented under authority of the Watershed Protection and Flood Prevention Act, PL-566, 83d Congress, 68 Stat. 666, as amended. The sponsoring local organizations are the Crawford County Conservation District and the City of Van Buren.

C. Description of Environmental Effects

The application of conservation land treatment measures and forest treatment measures would reduce sheet erosion 32 percent to an average annual rate of 1.5 tons per acre. Sediment deposition in Hollis Lake would be reduced 42 percent and would extend the life expectancy of the lake about 40 years. The reduction of flooding on the 1,030-acre flood plain would reduce the amounts of agricultural chemicals transported in surface flood water. The average annual area flooded would be reduced 76 percent in the watershed with a 99 percent reduction on Town Branch. Flows would be prolonged so that Flat Rock Creek would cease to flow only during extreme drought. When clearing and debris removal is being accomplished, the fishery habitat would be temporarily disturbed but would recover when construction is completed. The wooded swamp around Hollis Lake would continue to be an excellent wetland habitat. The present unsightly, unsanitary ditch through Van Buren would be improved and landscaped for aesthetic values. The reservoirs would provide 42 surface acres of water, including 11 acres for recreation. About 230 acres would be managed to improve cover and food for upland wildlife. Wildlife habitat would be developed on 26 acres of dams and spillways and other areas disturbed by the project. Archeological sites may be partially or completely lost during salvage operations.

FINAL WATERSHED WORK PLAN

FOR

WATERSHED PROTECTION, FLOOD PREVENTION, AND RECREATION

FLAT ROCK CREEK WATERSHED

Crawford County, Arkansas

Prepared Under the Authority of the Watershed
Protection and Flood Prevention Act,
(Public Law 566, 83d Congress, 68 Stat. 666),
as amended.

Prepared By:

Crawford County Conservation District
(Cosponsor)

City of Van Buren, Arkansas
(Cosponsor)

With Assistance By:

United States Department of Agriculture
Soil Conservation Service
Forest Service

State of Arkansas
Department of Commerce
Division of Soil and Water Resources

January 1975

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WATERSHED WORK PLAN AGREEMENT

between the

Crawford County Conservation District
Local Organization

City of Van Buren
Local Organization

(hereinafter referred to as the Sponsoring Local Organization)

State of Arkansas

and the

Soil Conservation Service
United States Department of Agriculture
(hereinafter referred to as the Service)

Whereas, application has heretofore been made to the Secretary of Agriculture by the Sponsoring Local Organization for assistance in preparing a plan for works of improvement for the Flat Rock Creek Watershed, State of Arkansas under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83d Congress, 68 Stat. 666), as amended; and

Whereas, the responsibility for administration of the Watershed Protection and Flood Prevention Act, as amended, has been assigned by the Secretary of Agriculture to the Service; and

Whereas, there has been developed through the cooperative efforts of the Sponsoring Local Organization and the Service a mutually satisfactory plan for the works of improvement for the Flat Rock Creek Watershed, State of Arkansas hereinafter referred to as the watershed work plan, which plan is annexed to and made a part of this agreement;

Now, therefore, in view of the foregoing considerations, the Sponsoring Local Organization and the Secretary of Agriculture, through the Service, hereby agree on the watershed work plan, and further agree that the works of improvement as set forth in said plan can be installed in about five years.

It is mutually agreed that in installing and operating and maintaining the works of improvement substantially in accordance with the terms, conditions, and stipulations provided for in the watershed work plan:

1. The Sponsoring Local Organization will acquire, with other than PL-566 funds, such land rights as will be needed in connection with the works of improvement. (Estimated Cost $703,400).

2. The Sponsoring Local Organization assures that comparable replacement dwellings will be available for individuals and persons displaced from dwellings, and will provide relocation assistance advisory services and relocation assistance, make the relocation payments to displaced persons, and otherwise comply with the real property acquisition policies contained in the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Public Law 91-646, 84 Stat. 1894) effective as of January 2, 1971, and the Regulations issued by the Secretary of Agriculture pursuant thereto. The costs of relocation payments will be shared by the Sponsoring Local Organization and the Service as follows:

	Sponsoring Local Organization (percent)	Service (percent)	Estimated Relocation Payment Costs (dollars)
Relocation Payments	22.8	77.2	3,000

3. The Sponsoring Local Organization will acquire or provide assurance that landowners or water users have acquired such water rights pursuant to State law as may be needed in the installation and operation of the works of improvement.

4. The percentages of construction costs of structural measures to be paid by the Sponsoring Local Organization and by the Service are as follows:

Works of Improvement	Sponsoring Local Organization (percent)	Service (percent)	Estimated Construction Cost (dollars)
Multiple Purpose Structure Number 1	18.17	81.83	253,287
Floodwater Retarding Structure Number 2	0	100.00	391,000
Channel Work	0	100.00	2,194,086

5. The percentages of the engineering costs to be borne by the Sponsoring Local Organization and the Service are as follows:

Works of Improvement	Sponsoring Local Organization (percent)	Service (percent)	Estimated Engineering Costs (dollars)
Multiple Purpose Structure Number 1	0	100.00	22,025
Floodwater Retarding Structure Number 2	0	100.00	34,911
Channel Numbers 1 and 2	0	100.00	195,900

6. The Sponsoring Local Organization and the Service will each bear their costs for project administration estimated at $21,985 and $530,956 respectively.

7. The Sponsoring Local Organization will obtain agreements from owners of not less than 50 percent of the land above each reservoir and floodwater retarding structure that they will carry out conservation farm or ranch plans on their land.

8. The Sponsoring Local Organization will provide assistance to landowners and operators to assure the installation of the land treatment measures shown in the watershed work plan.

9. The Sponsoring Local Organization will encourage landowners and operators to operate and maintain the land treatment measures for the protection and improvement of the watershed.

10. The Sponsoring Local Organization will be responsible for the operation and maintenance of the structural works of improvement by actually performing the work or arranging for such work in accordance with agreements to be entered into prior to issuing invitations to bid for construction work.

11. The costs shown in this agreement represent preliminary estimates. In finally determining the costs to be borne by the parties hereto, the actual costs incurred in the installation of works of improvement will be used.

12. This agreement is not a fund obligating document. Financial and other assistance to be furnished by the Service in carrying out the watershed work plan is contingent on the availability of appropriations for this purpose.

A separate agreement will be entered into between the Service and the Sponsoring Local Organization before either party initiates work involving the funds of the other party. Such arrangement will set forth in detail the financial and working arrangements and other conditions that are applicable to the specific works of improvement.

13. The watershed work plan may be amended or revised, and this agreement may be modified or terminated only by mutual agreement of the parties hereto except for cause. The Service may terminate financial and other assistance in whole, or in part, at any time whenever it is determined that the Sponsoring Local Organization has failed to comply with the conditions of this agreement. The Service shall promptly notify the Sponsoring Local Organization in writing of the determination and the reasons for the termination, together with the effective date. Payments made to the Sponsoring Local Organization or recoveries by the Service under projects terminated for cause shall be in accord with the legal rights and liabilities of the parties. An amendment to incorporate changes affecting one specific structural measure may be made by mutual agreement between the Service and the sponsor having specific responsibilities for the particular structural measure involved.

14. No member of or delegate to Congress, or resident commissioner, shall be admitted to any share or part of this agreement, or to any benefit that may arise therefrom; but this provision shall not be construed to extend to this agreement if made with a corporation for its general benefit.

15. The program conducted will be in compliance with all requirements respecting nondiscrimination as contained in the Civil Rights Act of 1964 and the regulations of the Secretary of Agriculture (7 C.F.R. 15.1-15.12), which provide that no person in the United States shall, on the ground of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subject to discrimination under any activity receiving Federal financial assistance.

16. This agreement will not become effective until the Service has issued a notification of approval and authorizes assistance.

Crawford County Conservation District
Local Organization

By [signature]

Title Chairman

P. O. Drawer B
Van Buren, Arkansas 72956
Address Zip Code

Date February 20, 1975

The signing of this agreement was authorized by a resolution of the governing body of the Crawford County Conservation District.
Local Organization

adopted at a meeting held on February 20, 1975.

[signature]
Secretary, Local Organization

P. O. Drawer B
Van Buren, Arkansas 72956
Address Zip Code

Date February 20, 1975

City of Van Buren, Arkansas

By [signature]

Title Mayor

Municipal Complex
Van Buren, Arkansas 72956
Address Zip Code

Date February 21, 1975

The signing of this agreement was authorized by a resolution of the governing body of the City of Van Buren, Arkansas.
Local Organization

adopted at a meeting held on February 17, 1975.

[signature]
City Clerk

Municipal Complex
Van Buren, Arkansas 72956
Address Zip Code

Date February 21, 1975

Appropriate and careful consideration has been given to the environmental statement prepared for this project and to the environmental aspects thereof.

Soil Conservation Service
United States Department of Agriculture

Approved by:

[signature]
State Conservationist

MAR 6 1975
Date

WATERSHED WORK PLAN

FLAT ROCK CREEK WATERSHED
Crawford County, Arkansas

January 1975

SUMMARY OF THE PLAN

This work plan for watershed protection, flood prevention, and recreation for the Flat Rock Creek Watershed was prepared by the Crawford County Conservation District and the City of Van Buren, Arkansas, as cosponsoring local organizations. Technical assistance was furnished by the United States Department of Agriculture, Soil Conservation Service, and Forest Service. Financial assistance in the development of the plan was provided by the State of Arkansas, Department of Commerce, Division of Soil and Water Resources.

The 18,952-acre watershed is located in west-central Arkansas in Crawford County. The county seat of Crawford County, Van Buren, and the community of Shibley are located in the watershed.

Flat Rock Creek and Town Branch are the main drainageways of the watershed. The watershed is bound on the north by Clear Creek, on the east by Mays Branch, on the south and southwest by the Arkansas River, and on the northwest by Lee Creek.

The topography of the watershed varies from the relatively flat Arkansas Valley flood plain in the southern portion of the watershed to mountainous slopes and steep stream valleys in the northern portion of the watershed. Elevations range from about 378 feet above mean sea level in the bottom land to about 1,100 feet along the watershed boundary.

The entire watershed is in the Arkansas Valley and Ridges Land Resource Area. The watershed is underlain by Paleozoic age shale and sandstone and unconsolidated alluvial materials of Quaternary and Recent ages.

The present watershed population is estimated to be about 8,000 of which 2,100 are rural and 5,900 are urban. There are presently about 150 farms in the watershed with an average size of 110 acres. The watershed flood plain is a 1,030-acre area subject to flood damage, as delineated by the 100-year frequency flood. Flood prevention benefits will accrue to the owners and operators of 30 farms and 167 urban properties in the flood plain. During the 100-year evaluation period, all floods produced average annual flood damages of $189,280.

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Washington, D. C. 20250

SUBJECT: WS-PL 566 - Flat Rock Creek Watershed, Arkansas DATE: NOV 4 1975

TO: M. J. Spears
State Conservationist, SCS
Little Rock, Arkansas

The watershed work plan for the Flat Rock Creek Watershed, Crawford County, Arkansas, has been approved by resolution adopted by the Committee on Agriculture and Forestry of the Senate on October 1, 1975, and by the Committee on Agriculture of the House of Representatives on October 29, 1975.

Until the limitation on construction starts is removed, no WF-08 funds may be used for any purpose on this watershed.

Subject to the foregoing, you are authorized to provide federal assistance in the installation of works of improvement on the Flat Rock Creek Watershed in accordance with the terms, conditions, and stipulations contained in the work plan when funds appropriated for this purpose are made available.

Please submit a field cost estimate SCS-WS-207 report in accordance with WPH 116.02. Show no funds expended in fiscal year 1976. Be sure to show the officially designated project code number on the line with the project name.

Norman A. Berg Acting

R. M. Davis
Administrator

Installation of this project will help to meet the objectives of the Western Arkansas Planning and Development District, the Ozarks Economic Development Region, and the Arkansas River Valley Resource Conservation and Development Project by developing, conserving, improving, and utilizing the natural resources of the area to enhance the economic and social welfare of the area's residents.

This work plan proposes the installation of land treatment and structural measures to be accomplished during a 5-year installation period. The total estimated cost of the project is $4,678,710 of which $3,609,671 will be borne by Public Law 566 funds and $1,069,039 will be borne by other funds.

Landowners and operators with assistance from federal and state agencies will install and maintain land treatment measures which will have a measurable effect on the reduction of flood damages. The cost of these measures is estimated to be $258,160. This includes $31,200 of Public Law 566 funds and $226,960 of other funds. Local interests in recent years have expended about $163,695 installing land treatment measures.

Structural measures consist of one multiple purpose structure (flood prevention and recreation), one floodwater retarding structure, and 7.4 miles of channel work. The total estimated cost of the structural measures is $4,420,550. The share from Public Law 566 funds is $3,578,471 and the share from other sources is $842,079.

The average annual benefits accruing from structural measures are distributed as follows:

Flood Prevention	
Damage Reduction	$180,830
Intensified Land Use	4,680
Changed Land Use	
Agricultural	5,480
Urban	66,000
Recreation	10,350
Redevelopment	24,700
Secondary	72,870
Total	$364,910

The average annual cost of structural measures is estimated to be $261,990. The ratio of average annual benefits to average annual costs of structural measures is 1.4 to 1. This ratio, excluding secondary benefits, is 1.1 to 1.

The Flat Rock Creek Improvement Project Area of the Crawford County Conservation District, Crawford County, Arkansas, has the powers of taxation and eminent domain and has filed a letter of intent to secure a watershed loan administered by the Farmers Home Administration. Funds obtained from this loan will be used to finance their share of installing the structural measures.

The City of Van Buren, Arkansas, will assume the local responsibility for construction and land rights for Multiple Purpose Structure Number 1.

Floodwater Retarding Structure Number 2 and the channel work will be operated and maintained at an estimated annual cost of $1,100 by the Crawford County Conservation District through the Flat Rock Creek Improvement Project Area. Multiple Purpose Structure Number 1 will be operated and maintained by the City of Van Buren, Arkansas, at an estimated annual cost of $300.

Measurable effects on the environment will result from the reduction of flooding, erosion rates, runoff rates, and sediment yields. Low-flow release will help to maintain streamflow.

WATERSHED RESOURCES - ENVIRONMENTAL SETTING

Physical Resources

The Flat Rock Creek Watershed comprises 18,952 acres in Crawford County. The watershed is in the west-central part of Arkansas, about 5 miles from Oklahoma and north of the Arkansas River. The Arkansas River Levee is the western boundary of the watershed. Part of the City of Van Buren is in the watershed. Fort Smith, the second largest city in Arkansas, is separated from the watershed by the Arkansas River. The 1970 population of Fort Smith was 62,802 and Van Buren was 8,373, according to the U. S. Bureau of Census Final Report PC(1)A5 Arkansas. The watershed population of 8,000 is 5,900 urban and 2,100 rural. (Information and data, except as otherwise noted by reference to source, were collected during watershed planning investigations by the Soil Conservation Service, U. S. Department of Agriculture.) This represents an increase of about 1,200 since 1960 due primarily to the growth of Van Buren.

The watershed is in the Arkansas-White-Red Water Resource Region. The water resource region has average annual rainfalls of 15 to 50 inches and has differences in vegetation from short-grass prairie to hardwood-pine forest. Soils within the region vary from shallow, dry, calcareous, and caliche soils to deep, wet, acid, and alluvial soils. Land use and management vary as widely as the above physical characteristics. The watershed is in the eastern part of the region and is characterized by high rainfall, forest vegetation, and deep, poorly to excessively drained, acidic soils.

The watershed is in the Lower Arkansas Water Resource Subregion which is generally the area draining into the Arkansas River between Tulsa, Oklahoma, and Pine Bluff, Arkansas. The eastern part of the subregion consists of steep, mountainous, forested areas bounding the narrow, level alluvium along the Arkansas River. The western part of the subregion is rolling hills with some upland farming on each side of wide alluvial areas along the Arkansas River and its tributaries. The watershed, which is in the central part of the Lower Arkansas Subregion, is more like the western part of the subregion.

The topography of the watershed varies from the relatively flat Arkansas Valley flood plain in the southern portion of the watershed to mountainous slopes and steep stream valleys in the northern portion of the watershed. Elevations range from about 378 feet above mean sea level in the bottom land to about 1,100 feet along the watershed boundary.

About 1,030 acres of bottom land in the watershed are subject to flooding. The flood plain includes two separate areas, 726 acres adjacent to Flat Rock Creek, and 304 acres that border Town Branch.

The upland soils are generally shallow to moderately deep, moderately permeable, well drained, and have developed from acid sandstone and shale; these are the Linker and Mountainburg Series. The terrace soils are deep, well drained to somewhat poorly drained, and moderately to slowly permeable; they are the Leadvale and Taft Series. The Arkansas River bottomland soils consist of deep alluvium that varies from very slowly permeable, poorly drained clays to rapidly permeable, excessively drained sands; they are the Severn, Iberia, and Bruno Series. The typical flood-plain soil is deep, poorly drained, and slowly permeable.

The land capabilities of the soils of the watershed are as follows:

Land Capability Class & Subclass 1/	Brief Description 2/	Watershed	Arkansas River: Alluvium	Flood Plain
		------Acres------		
I	Few limitations for cultivated crops	1,734	1,734	578
IIe	Moderate erosion hazard when cultivated	2,126	180	0
IIw	Moderate excess water for cultivated crops	163	163	123
IIIe	Severe erosion hazard when cultivated	4,505	0	0
IIIs	Soil limits choice of cultivated crops	2,250	2,250	0
IIIw	Severe limitations because of excess water	257	257	204
IVe	Very severe erosion hazard occasionally cropped	3,900	0	0
Vw	Excess wetness prevents cultivation	900	900	125
VIe	Should remain in permanent cover because of erosion hazard	664	0	0
VIs	Should remain in permanent cover because of shallow soil	960	0	0
VIIs	Suitable for limited grazing, woodland, and wildlife	1,493	0	0
Total		18,952	5,484	1,030

1/ Standard capability system developed by the Soil Conservation Service.
2/ Complete descriptions are given in Land Capability Classification Agricultural Handbook Number 210, SCS, USDA, 1961.

The lower case or subclass "w", following the Roman Numeral, indicates that excess water is the limiting factor in the use of the soil for agriculture. This may be the result of poor drainage of surface water, a high water table, an overflow hazard, or any combination of these factors. All of these conditions exist in the flood plain but the most common factor is the overflow hazard. There are no "e" or "s" subclasses located in the flood plain but are found within the watershed. The lower case "e" indicates that the main limitations is risk of erosion unless close-growing plant cover is maintained. Soils that are limited mainly because they are shallow, droughty, or stony are shown with a lower case "s".

The watershed is underlain by shale and sandstone of Paleozoic age and unconsolidated alluvial materials of Quaternary and Recent ages. The watershed is in the Arkansas Valley and Ridges Land Resource Area.

Based on a 30-year record of the U. S. Weather Bureau the average annual rainfall is 42.22 inches. The maximum recorded annual rainfall of 76.66 inches occurred in 1945. The minimum was 22.77 inches in 1901. The gage is located at Fort Smith, Arkansas.

The average monthly rainfall in inches is as follows:

January	2.66	July	2.80
February	3.43	August	2.92
March	3.47	September	3.64
April	4.24	October	3.45
May	5.26	November	3.18
June	4.35	December	2.82

Mean temperatures range from 38.8 degrees Fahrenheit in January to 83.0 degrees Fahrenheit in July. The minimum temperature of record is -15 degrees Fahrenheit and the maximum is 110 degrees Fahrenheit. The normal frost-free period of 234 days extends from March 21 to November 10.

Mineral resources in the Flat Rock Creek Watershed include deposits of sandstone, shale, gravel, sand, and natural gas. Sandstone deposits are extensive with a quarry located in the north-central portion of the watershed. Mining of shale for roadstone is limited to small scattered areas throughout the watershed uplands. Extensive sand and gravel deposits occur in the Arkansas River alluvium near the watershed outlet. Large quantities of natural gas reserves exist under the watershed.

The data presented in the U. S. Geological Survey Water-Supply Paper 1669-L indicated that an abundant supply of shallow ground water is available in Arkansas River alluvium in the southern part of the watershed. The supply of this water is adequate for future needs. Groundwater resources are virtually undeveloped in the northern (upland) part of the watershed. The Hartshorne Sandstone is a potential source of ground water in the uplands but wells drilled in the strata probably

would yield no more than 50 gpm. Ground water from the Arkansas River alluvium is mainly of the calcium-magnesium-bicarbonate type and is characterized by wide variations in the content of dissolved solids.

The range of concentrations (mg/l) of the principal constituents was iron (Fe), 0 to 21; bicarbonate (HCO_3), 95 to 622; sulfate (SO_4), 2 to 187; chloride (Cl), 2 to 164; nitrate (NO_3), 0 to 146; and calcium magnesium, 120 to 538. The specific conductance ranged from 234 to 1230 micromhos/cm at 25 degrees centigrade. Generally, ground water from the Arkansas River alluvium is suitable for domestic use; however, the iron and nitrate contents and the hardness may make the water undesirable for some industrial uses. Such ground water is rated as excellent to good and the rest as good to permissible for irrigation use.

Water samples were collected for analyses at the following locations: Sample Point Number 1 is in the SE¼, Section 30, Township 9 North, Range 31 West, on Town Branch just downstream from Interstate 540. Sample Point Number 2 is in the SE¼, Section 19, Township 9 North, Range 31 West, on Town Branch near the intersection of U. S. Highway 64 and Arkansas Highway 162. Sample Point Number 3 is in the SE¼, Section 29, Township 9 North, Range 31 West, where Flat Rock Creek crosses a county road about one mile east of Sample Point Number 1. Sample Point Number 4 is in the SW¼, Section 20, Township 9 North, Range 31 West, on Flat Rock Creek at Arkansas Highway 162 near its intersection with Interstate 540. Sample Point Number 5 is in the NW¼, Section 10, Township 8 North, Range 31 West, at Hollis Lake.

Water quality analyses were made on Town Branch, Flat Rock Creek, and Hollis Lake August 6, 1974. The following are the results of the analyses:

WATER QUALITY ANALYSES

Test	Town Branch Sample Point Number 1	Town Branch Sample Point Number 2	Flat Rock Creek Sample Point Number 3	Flat Rock Creek Sample Point Number 4	Hollis Lake Sample Point Number 5	Arkansas Water Quality Standards 1/
Iron Fe - mg/l	1.20	0.78	0.87	1.80	0.37	-
Manganese Nm - mg/l	0.0	3.7	0.2	1.4	0	-
Calcium Ca-mg/l	11	36	16	20	33	-
Magnesium Mg - mg/l	4	18	6	9	8	-
Alkalinity $CaCO_3$ - mg/l	266	90	70	78	140	-
Sulfate SO_4 - mg/l	16	130	18	18	7	120
Chloride Cl - mg/l	36.1	15.5	13.5	18.5	11.0	250
Nitrate N - mg/l	0.0	0.3	0.6	0.0	0.0	-
Phosphate PO_4 - mg/l	8.0	1.2	5.5	1.1	1.0	0.1
Total Hardness $CaCO_3$ - mg/l	46	166	64	88	114	-
Conductivity @ 25°C Micromhos/cm	780	420	210	230	290	-
pH	7.1	6.9	6.9	6.8	7.3	6.0 - 9.0
Water Temperature °C	22.5	21.0	22.5	23.0	24.5	34.0
Color - Apparent PT - CO Units	72	55	90	310	155	-
Turbidity JTU	310	25	35	110	55	50
Dissolved Oxygen DO - mg/l	0.0	2.8	0.0	4.8	2.5	5.0
Percent Oxygen Saturation	0	31	0	55	30	-
Suspended Solids mg/l	190	5	15	25	55	-

1/ Arkansas Water Quality Standards, Regulation Number 2, as amended, September 1973

Land use in the watershed is as follows:

Land Use	Acres	Percent
Total Watershed		
Cropland	4,714	25
Grassland	6,638	35
Forest Land	4,900	26
Urban & Other	2,700	14
Total	18,952	100
Flood Plain		
Cropland	660	64
Grassland	231	22
Forest Land	50	5
Urban & Other	89	9
Total	1,030	100

The upland forest land occurs as small, scattered areas of predominantly oak-hickory-elm in the rolling hills of the upland. The major tree species in the flood plain are willow, cottonwood, and ash.

The 726-acre flood plain of Flat Rock Creek is presently used for agricultural production even though about 200 of these acres are located within the city limits of Van Buren, Arkansas.

The flood plain of Town Branch, 304 acres, consists of about 242 acres used intensively for agricultural production and 62 acres of urban properties in Van Buren. About 78 acres of the agricultural land are inside the Van Buren city limits.

In the past, much of the watershed upland was used for cultivated crops, mostly cotton and corn. In many places, the shallow soils and steep slopes were marginally suited for cultivation. Consequently, crop production was abandoned and such areas were allowed to follow a natural succession of plants toward an oak-hickory forest. A few such fields are still cultivated and some are planted to pasture with improved grasses. Others are covered with plants, such as annual and perennial weeds, native grasses, persimmon, sassafras, and eastern red cedar.

About one mile of the upper reach of Town Branch is a natural stream channel and the lower five miles is a manmade ditch constructed to Hollis Lake in 1947. The manmade ditchbanks and berms have been well

maintained. Flat Rock Creek is a natural channel lined with trees from its source to where it empties into Hollis Lake. The channel has been modified slightly at railroad and highway crossings.

Town Branch is an ephemeral, polluted stream, typical of small urban tributaries. Two food-processing plants in south Van Buren discharge waste into Town Branch. The waste collects in small pools and causes unsanitary conditions. High stages on the Arkansas River cause some seepage through the sandy alluvium into the lower reaches of Town Branch. Flat Rock Creek is intermittent and flows about 80 percent of the year. In about one year out of five, the upland part of Flat Rock Creek will be dry but in Reaches III and IV, (Figure 4, Project Map), pools exist even during the most severe drought.

Van Buren is currently constructing a secondary treatment plant consisting of two digestors and a lagoon. The lagoon will have a pumping plant to discharge non-septic liquid into the Arkansas River. The project is to be completed in the early part of 1975. Damaged sewer lines in Van Buren are being repaired or replaced as the City has money to do this work. Only one industry is discharging any waste into the Van Buren sewer system and they are planning to install a system to handle their solid waste but they will continue to discharge liquid waste into the Van Buren's system.

Hollis Lake is a 300-acre shallow lake. It is a remnant of the Arkansas River. Both Town Branch and Flat Rock Creek empty into Hollis Lake. Overflow from the lake is through a ditch, built by the Corps of Engineers, to the Arkansas River.

About 300 acres of wetland surround Hollis Lake. The wetland is wooded, principally with willow, cottonwood, and ash. According to the United States Department of Interior, Fish and Wildlife Service, Circular C-39, Wetlands, the area is Type 7 "wooded swamp." Such wetlands are characterized by the water table near the surface during the dry part of the summer growing season and the soil submerged during periods of surface water runoff. This type of wetland is not uncommon in the Lower Arkansas Water Resource Subregion.

Plant and Animal Resources

Fish resources in the upland consist of about 100 farm ponds scattered throughout the area. They provide water for livestock and also fishing for many of the local residents. Many fish from the ponds find their way to Flat Rock Creek and help maintain this stream fishery resource. The main stem of Flat Rock Creek contains a variety of fish. Even during droughts, pools of water remain. Fish species found in the creek include bass, sunfish, bullheads, and channel catfish.

The main stem of Flat Rock Creek becomes a slow-running stream in the bottom land area. In addition to the fish population in the upland area, carp and buffalo are present. Town Branch has virtually no sport fishery. Fishing in Hollis Lake is not considered good. Occasionally, crappie, buffalo, and carp are caught by fishermen.

Fish samples were taken in November 1972 in Flat Rock Creek and the following pertinent data were obtained.

Sample locations

a. SW corner of SE 1/4, Section 29, T9N, R31W (lowland sample).
b. Center Section 17, T9N, R31W (upland sample).

Physical data

a. Pool: Riffle Ratio 1:1.
b. Pool Width: 15 feet - 25 feet.
c. Average Pool Depth: 3 feet.
d. Average Riffle Depth: 1/2 - 1 foot.
e. Bottom Type:
   (1) Clay and gravel in lowland sample.
   (2) Bedrock and cobble in upland sample.
f. Streambank Vegetation: Excellent.
g. Turbidity:
   (1) Slight in lowland sample.
   (2) Clear in upland sample.
h. Instream Habitat: Excellent.
i. Water Temperature: 54 degrees Fahrenheit (both samples).

Chemical data

a. Total Hardness: 51 mg/l.
b. pH: 7 (lowland); 4 (upland).
c. Dissolved Oxygen: 11 mg/l.

Biological data

Species	Number
European Carp	1
Redfin Shiner	8
Red Shiner	2
Gambusia	7
Black Bullhead	1
Stoneroller	4
Longear Sunfish	4
Blackspotted Topminnow	2
Big Eye Shiner	23
Redfin Darter	3
Brook Silverside	13
Bluntnose Minnow	1

The time of year and sampling method strongly influenced the sample results. November is a poor month to sample because of relatively low water temperatures. Two minnow seines (25 feet and 10 feet long by 4 feet deep) were used to sample. These seines restricted sampling to shallow water with a clean, uniform stream bottom.

Results indicate a small "healthy" stream. The physical data show that this stream will provide only a few annual man-hours of sport fishing. The chemical data show that the water is moderately productive. The sample composition, although taken in November with a water temperature of 54 degrees Fahrenheit, indicates above average diversity. There were 12 different species collected. This compares favorably to an "average Ozark stream" diversity of 25-30 species, according to Dr. Tom Buchanan, Westark Junior College, Fort Smith, Arkansas. Qualitatively, a riffle species (redfin darter), a river species (red shiner), a pool species (redfin shiner), small stream species (stoneroller and brook silverside), and a widespread species (big eye shiner) indicate that the diverse habitat required for a well-balanced aquatic community is present.

Cover in the intensively farmed bottom-land area is restricted to fence rows, turnrows, and woodland along streams. The limiting habitat for rabbits is cover. Furbearer populations are excellent along the streams. Dove and meadowlark populations are excellent in open areas. Quail and squirrel populations are confined principally to food and cover areas along fence rows and streams.

The 300 acres of wooded swamp which surround Hollis Lake contain an excellent rabbit and songbird population. Doves come to the lake regularly for water. Waterfowl use the area during fall and spring migration. Shorebirds are noted throughout the year. Aquatic species, such as turtles, snakes, and bullfrogs, are also abundant in and around the lake.

Much of the upland area is open fields with strips of woodland along streamcourses. There are a few scattered woodland areas of generally low quality hardwoods. Open fields are either fallow or in pasture with a few scattered cropland fields. The food and cover present is excellent for rabbits and songbirds and fair for quail, squirrels, doves, and furbearers.

Use of about 320 acres of woodland is dedicated by the landowners to wildlife management. Since almost all of the fish and wildlife resources are privately owned, public access to and use of the resources depend upon permission from the landowners. All parts of the watershed are physically accessible by county and farm roads.

Economic Resources

The Van Buren City Park (128 acres) is owned and operated by the City of Van Buren. The remaining area is in private ownership.

Types of farms range from the small part-time farming units to larger full-time family-sized units. There are about 150 farms in the watershed with an average size of 110 acres. This is below the average size of 148 acres for Crawford County and is due primarily to the large number of small farms, many of which are owned by nonfarm residents.

Principal crops grown and their average yields per acre under "without project" conditions in the flood plain are as follows: soybeans, 35 bushels; wheat, 50 bushels; corn, 50 bushels; and alfalfa, 5.1 tons. Yields of major crops in the bottom land adjacent to the flood plain are soybeans, 40 bushels; alfalfa, 6.0 tons; and corn, 70 bushels. In addition to the above-mentioned crops, commercial vegetable production within the bottom land contributes much to the local economy. Vegetables that are being produced include cabbage, cucumbers, peas, sweet corn, Irish and sweet potatoes, tomatoes, peppers, and squash. Hay yields about 1.5 tons per acre in the upland under average management.

In recent years, land values have sharply increased in the watershed. The average value of land and buildings in 1969 was $46,140 per farm, according to the 1969 Census of Agriculture, Section 2. The value of agricultural land varies according to the location and the intended land use. The value ranges from about $200 per acre in the upland to $500 per acre in the bottom land.

The value of all urban land in the watershed has also shown a sharp increase in the past 10 years. The present value of undeveloped urban land is about $2,000 per acre with little variation between upland and bottom land.

Van Buren and Fort Smith serve as the main trade centers for the residents of the watershed and the surrounding areas. These centers offer facilities to satisfy any need for rail, air, water, or truck transportation. Two railroads, the Missouri-Pacific and the St. Louis-San Francisco, furnish the rail transportation. There are 24 commercial flights in and out of the Fort Smith Municipal Air Terminal daily. Five bus companies and fifteen trucklines maintain home or division offices in Fort Smith and provide nationwide service. Barge transportation is available on the Arkansas River.

The road system serving the interior of the watershed consists of about 20 miles of highways, excluding city streets, and 50 miles of gravel

all-weather roads. The 20 miles of highways include about 8 miles of interstate system and 12 miles of state and county highways. This network of roads provides easy accessibility to any point within the watershed.

With the help of various organizations, both in Van Buren and Fort Smith, several new industrial plants have located in the area. In 1970, there were 250 manufacturing plants employing 16,600 workers, which is 28 percent of the labor force.

In 1970, the Van Buren labor area showed an unemployment rate of 10.8 percent. Agricultural employment decreased from 13 percent in 1960 to 7 percent in 1970. In 1970, the per capita income in Crawford County was $2,094. Crawford County is eligible to receive assistance under the Public Works and Economic Development Act of 1965 in the form of grants and small business loans.

Crawford County is one of six counties comprising the Western Arkansas Planning and Development District. This district was formed so that projects with a multi-county effect could be planned, sponsored, and initiated.

Crawford County is included in the Arkansas River Valley Resource Conservation and Development Project. This project encompasses an eight-county area and was established under the provisions of Title I of the Food and Agriculture Act of 1962. This project provides federal assistance for projects in the multi-county area that will conserve, improve, develop, or more efficiently utilize land, water, and other natural resources.

Recreational Resources

The Arkansas River is available for activities such as boating, fishing, limited swimming, and waterskiing. A 10-acre private lake just north of Van Buren provides fishing on a user-fee basis. Lake Fort Smith, 20 miles north of Van Buren, consists of a 438-acre municipal water reservoir and a 15-acre state park, but swimming and skiing are prohibited.

Shores Lake, 30 miles northeast of Van Buren, is a U. S. Forest Service lake of 82 acres which was constructed for recreation. Swimming, boating, and sanitary facilities are available. Sugarloaf Lake, 30 miles south of Van Buren, is an Arkansas Game and Fish recreation lake of 334 acres and is one of the most heavily fished small lakes in the state. Boat docks, nature trails, picnicking, and sanitary facilities are available. The city park and two city-owned playgrounds, of 3 acres each provide land-based recreational facilities. The seven public school playgrounds provide some recreational opportunities. A 116-acre privately owned hunting and fishing club includes part of the wooded swamp near Hollis Lake.

Archeological and Historic Resources

The Butterfield Stage Line passed through Van Buren and crossed the Arkansas River there. Traces of Indian artifacts on the sand ridges in the bottom land south of Van Buren indicate habitation by Indians. The archeological resource base for the watershed area is relatively unknown. Archeological research in this portion of Arkansas has been minimal and the general cultural history of the region is defined primarily in reference to archeological research conducted in other areas of Arkansas and in surrounding states. Presently, there is no synthesis of the prehistory of west-central Arkansas.

The most intensive archeological survey of the western Arkansas River Valley (within the state of Arkansas) was conducted in 1965 within the area now inundated by Ozark Reservoir near the town of Ozark, Arkansas (Hoffman 1965). Fifty-nine prehistoric sites were identified and recorded. Based on information provided by this survey, a tentative, general cultural history for the area was projected. The summary of the aboriginal occupation of the Ozark Reservoir area (Hoffman 1965: 75-84) was based somewhat on earlier research conducted at the Tom's Brook shelter, north of Clarksville, Arkansas (Bartlett 1963).

Hoffman's summary outlines the known prehistoric occupation of the area with reference to the artifact types found or reported. The general summary is presented below by stages and substages (Hoffman 1965: 75-84).

Paleo-Indian (12,000 - 9000 B.C.)

There is no positive evidence for occupation in the area during the Paleo-Indian stage. Allegedly, a point similar to a Clovis point was found near Frog Bayou, but this find was not documented.

Archaic 1 (8000 - 5000 B.C.)

This substage was represented only by scattered surface finds of Dalton points. All of these occurred on upland sites situated on high terraces.

Archaic 2 (5000 - 2000 B.C.)

This substage is characterized by Big Sandy and Johnson projectile point types (Bartlett 1963). No Johnson points were found during the Ozark Reservoir survey. Possible Big Sandy points were found at only two sites, both located in the uplands.

Archaic 3 (2000 - 1000 B.C.)

The Archaic 3 substage is defined on the basis of corner-notched (Williams and Bulverde) points and contracting-stemmed (Gary and Langtry) points. This substage in the Ozark Reservoir area was represented at 39 sites.

This is the first extensive occupation for which there is evidence. The sites occurred both in the uplands and lowlands. In the lowlands the sites were located primarily on old natural levees. In the uplands the sites were situated on the edges overlooking the Arkansas River Valley.

Early Ceramic (The Gober Complex) (1000 B.C. - A.D. 700)

The three artifactual hallmarks of the Gober Complex are the narrow pointed-stem Gary projectile point, clay-tempered pottery, and the argillite spade. Sites of this complex were located in the bottom lands on natural levees or, as in one case, on a slight erosional terrace surrounded on three sides by streams.

Late Ceramic (The McClure Complex) (A.D. 700 - 1700)

There are two diagnostic artifacts of the McClure Complex. These are arrow points and shell-tempered pottery. The arrow point types definitely associated with the complex are the Fresno and Reed types, plus two unnamed types--a long isosceles triangular type and a leaf-shaped stemless arrow point with convex sides and a straight or rounded base. McClure Complex sites generally occur in the lowlands.

It should be apparent from the above outline that knowledge of the archeological resource base of west-central Arkansas is minimal. While the sequence of prehistoric occupation in the area is generally known, information pertaining to particular stages of occupation is lacking. There has not been adequate archeological research in the region to even document the overall culture history.

The Arkansas Archeological Survey's reconnaissance of the watershed resulted in the identification of nine sites, three of which were historic and six that were prehistoric. The number, name, and a brief description of each of these sites follows:

3CW81 (Stevenson Site Number 1)

This is the site of a log cabin built in 1837 by James Graham Stevenson. The cabin was used as headquarters by Confederate General Price during his retreat from the Battle of Pea Ridge in northwest Arkansas. Price's Confederate company camped along Flat Rock Creek before crossing the Arkansas River.

Physical evidence of the site does not exist and no materials were collected.

3CW82 (Stevenson Site Number 2)

This is an historic dwelling built in 1854 by James Graham Stevenson. Stevenson, a Civil War veteran (Union Army), was Mrs. T. J. Garner's great grandfather. The frame and front of this structure are made from

hewn logs, a couple of which are 30 feet long. The house is still in good condition and is presently occupied.

No materials were collected from this site.

3CW83 (Garner Site)

This is an area of a high second terrace above a tributary of Flat Rock Creek which yielded concentrations of lithic debris (mostly flakes) and several other nondiagnostic artifacts. It was reported that over the last 50 years, a good many large projectile points had been collected from the area. This suggests that the site may be Archaic. A salt lick was reported to exist within a half mile of the site.

3CW84 (Garner Cemetery Site)

This is an area yielding chert flakes and large projectile points according to Mrs. T. J. Garner. Survey of the area only produced a couple of chert flakes. The site is situated on a high second terrace above Flat Rock Creek. The site may be Archaic. A salt lick was reported to exist within a half-mile of the site.

3CW85 (Slate Branch Site)

This site was poorly defined solely on the basis of a couple of chert flakes and one nondiagnostic chert tool. In addition, several historic ceramic sherds were found in the area. The site is located in a primary stream terrace above Flat Rock Creek. It was reported that a spring used to exist in the immediate vicinity.

3CW86 (Vinsett Site Number 1)

This is the area of a widely dispersed concentration of lithic materials situated on a second terrace on the eastern side of Flat Rock Creek. The materials collected include chert cobbles, flakes, and a couple biface fragments. No diagnostic artifacts were collected. The site may be Archaic.

3CW87 (Vinsett Site Number 2)

This is the area of a relatively dense concentration of lithic materials situated on a second terrace on the eastern side of Flat Rock Creek. The materials collected include chert cobbles, flakes, biface fragments, scrapers, a hammerstone, and several broken projectile point fragments. None of the artifacts were diagnostic. The site is probably Archaic.

3CW88 (Vinsett Site Number 3)

This site was defined solely on the basis of one chert flake and one nondiagnostic chert biface. The site is situated on the crest of a high hill on the eastern side of Flat Rock Creek. The site may be Archaic.

3CW89 (Railroad Site)

This is a 300-400 meter square area scattered with stoneware ceramics, old bricks, pieces of metal, and fragments of slate or coal. The soil of the site is stained grey, possibly due to coal. A couple of chert cobbles were found but their prehistoric affinity is questionable. This is the probable location of an old railroad station or similar facility. A modern railroad is nearby.

Based on the land forms with which the above sites were associated, it is within reason to suggest that they were occupied during the Middle or Late Archaic Periods.

None of the properties listed in the October 1974 report supplied by the State Historic Preservation Liaison Officer is located in the watershed.

Soil, Water, and Plant Management Status

Most of the needed land use changes have been made during the last 20 years; that is, most of the marginal cropland in the upland part of the watershed has been converted to permanent vegetation. Woodland in three areas totaling 145 acres has been converted to cropland. The urban sprawl, in and around Van Buren, has engulfed considerable acreage in the vicinity of the watershed flood plain. Based on a continuation of this trend, it appears likely that urban uses will encroach on the flood plain in the future even without the project. Forest land acreage in the watershed is static now, and any decrease in this acreage is expected to result primarily from urban expansion on about 80 acres.

The conservation land treatment measures in the upland have changed with the changes in land use. The changes on the marginal cropland have been from conservation treatments necessary for farming, such as stripcropping, contour farming, and crop rotation, to those treatments needed for permanent cover, such as tree planting, pasture planting, controlled grazing, rotational grazing, livestock water development, and wildlife habitat development.

Crops, such as cotton, alfalfa, and vegetables, that are severely damaged by flooding or that have high capital inputs are not grown in the frequently inundated flood plain. This area is usually used for soybean production.

Woodland is in a state of deterioration as a result of many years of neglect, indiscriminate burning and grazing, and destructive logging practices. While most of the damage occurred years ago, these poor woodland conditions are perpetuated on most of the tracts by present neglect and abuse. Examination of the forested areas showed that 40 percent has moderate to severe grazing damage.

The watershed is served by the Crawford County Conservation District. Assistance is provided to the district by the Soil Conservation Service field office at Van Buren, Arkansas. The conservation district has about 60 cooperators who manage 44 percent of the nonurban land in the watershed. Basic conservation plans have been developed for 55 cooperators and cover 41 percent of the nonurban land in the watershed.

The applied conservation measures represent an expenditure of $163,695, which is 42 percent of the total land treatment needs in the watershed. About 44 percent of the cropland and 64 percent of the grassland have been adequately treated.

Forest fire protection is available through the Arkansas Forestry Commission, in cooperation with the U. S. Forest Service, through the Clarke-McNary Cooperative Fire Control Program. Other available cooperative federal-state forestry programs include forest management, reforestation, general forestry assistance, and insect and disease control.

WATER AND RELATED LAND RESOURCE PROBLEMS

Land and Water Management

Proper conservation land treatment practices are difficult to apply in areas where excess water problems exist. Conservation cropping systems that include flood-intolerant crops cannot be practiced on about 50 percent of the flood plain because of the flood problem. Crop residue management is difficult because the floodwater can cause drifting or removal of crop residues before they are incorporated into the soils. Some of the problems in land management caused by excess water are delayed cultural practices, such as preparing the seedbed, planting, and cultivating; increased production costs because replanting is often necessary; unharvested mature crops; and decreased quality of farm products.

The lag in the application of land treatment measures in the upland can be attributed to the large number of small ownerships that are primarily rural residences. This group does not depend on farming for their total income. Farming may be an income supplement or it may be only a hobby. On these farms, woodland protection and improvement and proper grazing are the practices most needed. Also, the marginally suited soils that are cultivated need to be converted to permanent vegetation. Reforestation is needed on 900 acres for the use of land within its capabilities.

Floodwater Damage

The 100-year frequency flood would inundate 1,030 acres and would cause an estimated $740,000 direct damage to the 167 urban properties that are subject to flooding. The location of the urban flood plain is shown on the Urban Flood Plain Map (Figure 3). As forested land, grassland, and idle land are altered by urbanization, runoff will increase, thus tending to increase flood stages and floodwater damages.

For purposes of evaluation, the flood plain was divided into five reaches which are located as follows:

Reach I: Town Branch - Hollis Lake to the Missouri-Pacific Railroad.

Reach II: Town Branch - Missouri-Pacific Railroad to Multiple Purpose Structure Number 1.

Reach III: Flat Rock Creek - Hollis Lake to Interstate 540.

Reach IV: Flat Rock Creek - Interstate 540 to Missouri-Pacific Railroad.

Reach V: Flat Rock Creek - Missouri-Pacific Railroad to Structure Number 2.

Reach II contains only 62 acres of flood plain or about 6 percent of the watershed flood plain. This acreage consists of the urban properties along Town Branch in Van Buren. Nonagricultural damages in this reach depend on flood depth. Flooding occurs frequently in this urban area.

The damages result from shallow (less than 5 feet) first floor flooding to industrial, commercial, and residential properties. Carpets, furniture, unsealed foods, vehicles, lawns, gardens, garages, storage buildings, lawnmowers, appliances, wood flooring, air conditioners, floor furnaces, basements, wall paneling, Sheetrock, clothing, machinery, tools, supplies, and lumber are examples of items that are damaged by water and sediment when these properties are flooded.

Reaches I and III contain 242 acres and 423 acres of the flood plain, respectively. The combined acreage in these reaches constitutes 65 percent of the entire flood plain in the watershed. These reaches suffer frequent flooding with three to four damaging floods occurring each year. Nevertheless, both reaches are used intensively for agricultural production. About 86 percent of the flood plain in these two reaches is used for crop production and the balance is used for grassland and miscellaneous uses. The frequent flooding results in severe crop and pasture damages. Crops are damaged by delayed planting, inundation, oxygen deficiency in root zone, increased weed competition, decreased quality of crops, scour, and sedimentation.

Reach IV (184 acres) and Reach V (119 acres) are similar and contain 29 percent of the total watershed flood plain. Flooding is frequent with an average of about two floods annually. The valley is narrower in these reaches than it is downstream and the soils are not well suited to crop production. This accounts for the less intense land use in these reaches with cropland occupying about 46 percent of the flood plain. Grassland and miscellaneous uses account for the other 54 percent.

The variations among reaches, with regard to land use and intensity of production, are reflected in the damageable values and floodwater damages. The following table presents, for the agricultural reaches, the estimated per-acre value of flood plain production; the average annual crop and pasture damage per acre; and the average annual flood damage as a percent of the value:

Reach	Location	Damageable Value Per Acre (dollars)	Annual Crop and Pasture Damage Per Acre (dollars)	Percent Annual Damage Per Acre
I	Town Branch - Hollis Lake to Missouri-Pacific Railroad	143.00	16.15	11
III	Flat Rock Creek - Hollis Lake to Interstate 540	165.00	30.44	18
IV	Flat Rock Creek - Interstate 540 to Missouri-Pacific Railroad	88.00	19.13	21
V	Flat Rock Creek - Missouri-Pacific Railroad to Structure Number 2	66.00	3.61	5

The other agricultural damages experienced in the watershed are relatively minor and consist of fence damages in Reaches IV and V. There are no other agricultural damages in Reaches I, II, or III.

Major floods are defined as those which overflow 50 percent or more of the area inundated by the 100-year flood. The severity of flooding in the agricultural reaches (I, III, IV, and V) is substantiated by the fact that the 2-year frequency flood inundates 49 percent of the entire flood plain in these reaches. Of the total agricultural damages produced during the 100-year evaluation period, the majority are caused by small frequent floods. Floods up to and including the 2-year frequency account for approximately 76 percent of the total agricultural damage from all floods.

A typical major flood occurred in April 1964. This flood approximated the 25-year frequency event and inundated about 880 acres of the flood plain. This flood occurred when direct crop damage was minimal except to winter small grain which is susceptible to flood damage in April. Land preparation for soybeans was delayed as much as three weeks but some of this delay would have resulted from the rain and poor surface runoff even if overbank flooding had not occurred. About 17 percent of the damages were agricultural and about 83 percent were nonagricultural and indirect. The total damage caused by this flood is estimated to be $501,400, of which $415,000 was damage to urban properties.

The average annual floodwater damages amount to $189,280 of which $144,780 is nonagricultural.

Indirect damages that occur as a result of actual or threatened flooding include the interruption of travel; loss of income by workers who commute; loss or delay of sales by local merchants; and the additional time, distance, cost, and general inconvenience associated with marketing farm products; delivering mail; and transporting children to school. Indirect damages also occur in Van Buren when families evacuate their homes during a flood threat; however, the chance of floods severe enough to cause a direct hazard to human life in Van Buren is considered insignificant. The cost incurred by businessmen during a flood threat to move or elevate merchandise is an indirect damage.

Erosion Damage

Erosion damage is a minor problem in the watershed. Moderate to severe erosion exists only on small, isolated areas. Sheet erosion, which is 88 percent of the gross erosion in the watershed has a rate of 2.2 tons per acre. This rate will not reduce long-term soil productivity. Roadside erosion is 9 percent and streambank erosion is 3 percent of the gross erosion in the watershed.

Sediment Damage

Although erosion rates are not excessive, sediment from the watershed is gradually destroying Hollis Lake and the wooded swamp surrounding it. At the present erosion and sedimentation rates, Hollis Lake is receiving an average of more than 13.5 acre-feet of sediment per year. The depletion rate of the lake is 1.8 percent per year, resulting in a projected life expectancy of about 55 years. Hollis Lake is in the last stages of its usefulness as a fishery habitat and is significantly damaged by sediment deposition. The average sediment concentration in the lake is about 450 mg/l.

Drainage Problems

About 600 acres of the soils in the watershed were classified as poorly drained. The drainage problems have been adequately solved on most of

these areas. The remaining need for drainage is limited to onfarm needs and can be alleviated by accelerating programs presently available.

Recreation Problems

The Arkansas Statewide Comprehensive Outdoor Recreation Plan, 1969, shows that swimming, boating, picnicking, and other recreation facilities are not adequate in the vicinity to meet the needs of the local residents. The 75,000 residents of Van Buren and Fort Smith are among the potential users of recreational resources in the watershed. The City of Van Buren is interested in developing additional recreational facilities in the city park such as bridle paths, nature trails, fishing, skating rink, and amphi-theater.

Plant and Animal Resource Problems

The major fish and wildlife resource problems center around sediment deposition in Hollis Lake. The water control outlet for the lake is as high as feasible; therefore, the only way to protect the lake and surrounding wetland is to reduce the rate of sedimentation.

There is a need for management of selected areas throughout the watershed for wildlife purposes and the improvement of wooded areas for wildlife improvement. There is a need for maintaining woody habitat along watershed streams because this represents unique habitat in the watershed.

Water Quality Problems

Town Branch is an ephemeral, polluted stream, typical of small urban tributaries. The waste from two food-processing plants collects in small pools in Town Branch and causes unsanitary conditions. The elimination of waste discharge into Town Branch and the creation of a constant gradient ditch bottom would help alleviate the problems.

Economic and Social Problems

Even though many jobs have been created in the industrial segment of the economy, the problems of unemployment (10.8 percent) and underemployment continue to plague the local economy.

Income levels can also be cited as evidence of the poverty-stricken economy. In 1970, the per capita income in Crawford County was $2,094 which compares to the state average of $2,642 and the national average of $3,687.

The low incomes are detrimental. The purchasing power of individuals and families is limited. The tax base is reduced which, in turn, limits the revenue available to finance community facilities and development projects that will benefit the public in general.

There is a high degree of awareness of the need for expanding the economic opportunities and improving the social welfare of the residents of the area, as evidenced by the establishment of the following: (1) Arkansas Valley Resource Conservation and Development Project, (2) Crawford County Development Council, (3) Western Arkansas Planning and Development District, and (4) the Ozarks Economic Development Region.

PROJECTS OF OTHER AGENCIES

The Corps of Engineers has provided many improvements in the Arkansas River Basin under various authorizations by Congress since the first authorization of the Flood Control Act of 1948. Construction of Lock and Dam 13 on the Arkansas River has been completed. This structure, which is one of a series of seventeen locks and dams constructed to make the Arkansas River navigable, is located downstream from the old outlet of the Flat Rock Creek Watershed.

In order to mitigate the adverse effect which the construction of this lock and dam would have on the interior drainage within the Flat Rock Creek Watershed, the Corps of Engineers constructed a new outlet channel. This channel starts at the lower end of Hollis Lake and extends about one and one-half miles southeast and then outlets through a box culvert through the Levee into an open ditch which flows into the Arkansas River. The channel provides an adequate outlet for the Flat Rock Creek Watershed.

PROJECT FORMULATION

An application for assistance in solving problems related to land and water resources was made by a group of landowners in March 1965. This application was submitted to the Arkansas Soil and Water Conservation Commission. The Commission approved the application and the project was later given a planning priority by the Governor. The Soil Conservation Service prepared a preliminary report setting forth the project proposal. This report was used by the local group in creating the Flat Rock Creek Improvement Project Area of the Crawford County Conservation District, a legal subdivision of the state government. At least six articles concerning the formation of the improvement project area and the project were published in the local newspaper. A public hearing was held on December 4, 1968. Numerous meetings of the steering committee and local and state agencies were held during the planning of the project.

A public informal field level review was held on September 8, 1971. The purpose of the review was to explain the project in detail to the sponsors, the general public, and interested federal, state, and local agencies and to receive comments on the plan.

The Environmental Protection Agency recommended: (1) that green belts be established in the urban area along the channel; (2) that channel alterations be designed to preserve the natural setting with channel and concrete channel construction minimized; and (3) that provisions be made for mitigation of streamflow losses in Flat Rock Creek and Town Branch for the 100-year life of the project.

In regard to the establishment of green belts, a landscape plan will be developed along Town Branch within the urban area. The landscape plan will be implemented as part of this project. The Van Buren City Council has agreed to initiate an ordinance whereby future improvements or developments within the Town Branch 100-year frequency flood plain will be restricted to those projects that will not contribute to the flooding problem nor be susceptible to flood damage beyond minor repair and cleanup. Improvements, such as parking lots, recreational areas, or educational nature trails, will be permitted. The city will consider development location, damageable values, flood proofing, and flooding depths before issuing development permits.

The channel work and concrete construction have been held to a minimum and the establishment of vegetation will be accomplished immediately following the channel construction. The curved channel should also help to give the area a "natural setting" appearance.

Design features provide for augmentation of streamflow in Flat Rock Creek for the life of the project by designing a prolonged principal spillway release in Floodwater Retarding Structure Number 2. It is not feasible to plan a prolonged release for Multiple Purpose Structure Number 1 because of limited storage characteristics within the structure caused by the location of the Van Buren Community Building immediately upstream from the proposed lake. Town Branch is not a live stream and has a relatively small drainage area.

The U. S. Bureau of Sports Fishery and Wildlife recommended that the channels be designed and constructed so as to minimize the amount of sediment movement and channel degradation that would take place within the watershed. They suggested that every reasonable effort should be made in planning, construction, and operation of the project to prevent further deterioration of Hollis Lake. These recommendations are being followed.

The Arkansas Game and Fish Commission reviewed the plan and concurred in the report of the U. S. Department of Interior Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife.

Dr. Tom Buchanan, Ichthyologist, Westark Junior College, Fort Smith, Arkansas, assisted in fish collections and was consulted on interpretation of results.

The Arkansas Historic Preservation Program provides the Soil Conservation Service with a listing of Arkansas historic places listed in the National Register, places pending inclusion in the National Register, and properties currently under consideration for nomination to the National Register.

Dr. Charles R. McGimsey, III, Director, Arkansas Archeological Survey, was notified when the project was authorized on March 17, 1969.

On August 26, 1971, the Survey was sent a copy of the Draft Work Plan and was invited to attend the informal field level review on September 8, 1971.

A cooperative agreement between the Arkansas Archeological Survey and the Soil Conservation Service provided for the State to furnish qualified archeologists, supervision, equipment, and material to perform drawings, sketches, and technical specifications of the area to be surveyed and reimbursed the state for performing the archeological survey. The Survey: (1) determined if archeological resources exist within the area committed to the project; (2) recorded, identified, and appraised any located resources; (3) evaluated the impact of project installation on each resource; (4) provided recommendations for mitigation of anticipated adverse impacts; and (5) provided estimates of costs required for mitigation, salvage, or protection. The final report by the Survey was furnished to the Soil Conservation Service in July 1974.

All suggestions and recommendations were reviewed carefully before preparation of the work plan.

Objectives

After consideration of the needs of the community for resource development, economic growth, and the physical capabilities of the watershed, the following objectives were agreed upon by the sponsoring local organizations and the Soil Conservation Service:

1. To install needed land treatment measures which will:

   a. Increase the efficiency of land use and obtain maximum benefits from the proposed improvements.

   b. Reduce the soil loss in the watershed to an average of less than 2.0 tons per acre per year.

2. To install structural measures which will provide protection for the area which is now subject to frequent damaging floods and reduce damages from the floods as follows:

   a. Reduce damages to the agricultural flood plain by at least 80 percent.

b. Control the flooding from the 100-year frequency storm within the City of Van Buren.

3. To install a recreation development at a multiple purpose structure in the Van Buren City Park which will accommodate the following number of people at any one time for the various activities listed below:

Sightseeing	60
Fishing	40
Picnicking	30
Boating	5
Frog Gigging	15
Total	150

4. To provide for maximum feasible protection for fish and wildlife resources.

5. To provide drop structures and other appurtenances to the channels, as may be required, to protect them from excessive streambank erosion and channel aggradation.

6. To install a system of land treatment and structural measures which will provide an acceptable level of protection at the lowest cost considering the installation, operation, maintenance and replacement costs.

7. To make the watershed an outstanding example of soil and water conservation.

An analysis of the land treatment data in the conservation district records indicated that the land treatment goals which had been agreed upon were realistic and could be accomplished during the 5-year installation period if Public Law 566 funds for additional technical assistance and forest fire control equipment were provided as part of this project.

The forest land treatment program was developed from information acquired during a field survey of the watershed, subsequent consultation by the Arkansas Forestry Commission and the U. S. Forest Service, and from land use recommendations by the Soil Conservation Service. This program is based on the needs beyond those met by the existing cooperative federal-state forestry programs. The goals are realistic and can be accomplished during the 5-year installation period. Public Law 566 funds for accelerated technical assistance are provided as part of the project.

The 1969 Arkansas fire loss index goal was 0.47 percent and the watershed protection goal was 0.20 percent. The average percent burn for the years 1965 through 1969 was 1.10 percent, exceeding both goals. A fire prevention contactor program will be set up to strengthen the prevention efforts in the watershed.

Areas that are being or will be converted to urban use are recognized by the sponsors as sources of potentially damaging sediment. The sponsors intend to cooperate fully with all agencies and groups that can assist in providing the necessary legislation and technical knowledge to control this problem. The development of good plans for drainage and runoff water disposal for severely damaged urban areas will be a by-product of the passage of enabling legislation.

It was determined early in the project formulation stage that it would be necessary to install floodwater retarding structures at all feasible locations in order to provide the desired level of protection from flooding and to limit the extent of needed channel work. In addition to the two structures which are planned as part of this project, a survey and preliminary design were made for a structure to be located on Neal Prairie Creek. The required floodwater storage could not be obtained at this location, so this structure was eliminated. Detailed channel studies were made to determine stability and to develop the design which would be the least harmful to fish and wildlife resources within the watershed. Special consideration was given to the needs of Hollis Lake.

An ungated port is planned in Structure Number 2 to provide a constant release of water into Flat Rock Creek at all times except during periods of extreme drought. It will result in an increased flow in the stream about 90 percent of the time.

A number of systems of structural measures were analyzed to determine which was the most feasible. It was found that channel work on both Town Branch and Flat Rock Creek would be required. The system, as shown in this plan, proved to be the most feasible. It provides one multiple-purpose structure (flood prevention and recreation), one single-purpose structure, and approximately 7.4 miles of channel work.

The measures planned for Town Branch do not provide complete urban protection from the 100-year storm. The Van Buren City Council will initiate an ordinance to restrict development within the area still subject to flooding. Improvements, such as parking lots, recreational areas, or educational nature trails, will be permitted. The city will consider development location, damageable values, flood proofing, and flooding depths before issuing development permits within this area.

These structural measures provide the highest level of protection which it is feasible to provide. The sponsors have agreed that the urban protection is adequate. The installation of the measures proposed in this plan will meet all other project objectives.

Environmental Considerations

The multiple purpose structure for flood prevention and recreation is located in the Van Buren City Park. Adequate sanitary facilities are available at this location.

The single purpose floodwater retarding structure has potential for limited recreation use. However, no facilities or public access are planned at this structure. Unless and until adequate sanitary facilities are provided which meet state and local health requirements, the sponsors will prohibit general public access to the site.

Structure Number 2 will provide for low-flow augmentation. This water will help maintain streamflow throughout the year and will operate continuously except during extreme droughts. This release will help stabilize the habitat for some fish species.

One dwelling will be relocated from the pool area of Structure Number 2. Relocation will consist of moving the present dwelling or providing financial assistance to obtain a suitable replacement.

Alternatives

The alternatives to the proposed project that were considered are as follows: (1) an accelerated program for watershed protection by applying land treatment measures, changing land use, and zoning and insuring urban areas; (2) accelerated land treatment measures and two floodwater retarding structures; (3) accelerated land treatment measures and channel work; (4) levees and floodways; (5) recreational development at Hollis Lake; and (6) no project.

Alternative (1) consists of accelerating the application of conservation land treatment measures described as part of the proposed project; converting the agricultural land that is damaged most in the flood plain to uses with lower damagable values such as wildlife and recreation, forest land, or pasture; and zoning and insuring urban areas. Land treatment measures would reduce flooding about 3 percent and would reduce associated damages about $1,830 annually. Sheet erosion would be reduced about 32 percent or to an average annual rate of 1.5 tons per acre.

Changing land use of the 660 acres of cropland in the flood plain to uses such as wildlife and recreation, forest, or pasture would eliminate the damages to cropland and would significantly reduce the $21,000 average annual floodwater damages to agriculture. The average annual loss in agricultural income is estimated to be $85,000. Changing the land use in the urban developed area would involve 16 commercial properties, 4 industrial properties, and 147 residences. Estimated cost of this change

is $15,000,000. The combined programs of zoning and flood insurance for the urban area would not relieve the flood damages to properties presently in the flood plain but would compensate for dollar damage. The annual cost for this protection is estimated to be $150,000. Indirect damages would still exist. Flood insurance costs would be greater than the flood damage. Zoning, so that new developments in the flood plain could be restricted, would prevent increasing flood damage. This alternative would have no adverse effects from floodwater retarding structures or channel work.

Alternative (2) provides for accelerated land treatment at an estimated cost of $75,000 over the entire watershed with all the needed treatment being applied to 10,500 acres during the installation period. The details of the land treatment measures are discussed as part of the proposed project. Structure Number 1 would provide some reduction in damages to the upper portion of Reach II but would have little effect on flood damages in the lower portion. Floodwater retardation by Structure Number 2 would not provide the needed level of protection for the Flat Rock Creek flood plain. The adverse environmental impacts associated with the proposed channel work would be eliminated. The average annual cost of the structures, including water storage for recreation in Structure Number 1, and land treatment, would be about $64,000 and the benefits would be $22,000. The amount of land required for this alternative would be practically the same as for the proposed project.

Alternative (3) involves accelerated land treatment measures with channel work. The entire watershed would receive accelerated land treatment measures with all the needed treatment being applied to 10,500 acres during the installation period. The channels would have to be enlarged sufficiently to carry the peak flows for the needed level of protection. This would necessitate both widening and deepening the channels and the removal of all the habitat from one side of the creeks if the present alignment were followed. If the channels were offset, the habitat would be undisturbed but the amount of new land required for the channels would be prohibitive.

Both the enlargement of the existing channel or the construction of a new channel would increase sedimentation in Hollis Lake during construction but overall, there would be a reduction. Channel work along Town Branch and Flat Rock Creek would cost about $3,300,000 and would require about 40 acres of land. The needed recreational resource would remain undeveloped.

Alternative (4) consists of construction of levees and floodways in Van Buren; this would require considerable land and the relocation of several properties. Street crossings would need to be raised to go over the levees; also, ditches and pumping plants would be required to remove excess runoff water from the landside of the levees. The costs would be high because of the need to purchase developed urban land for rights-of-way.

The environment in the floodway in Van Buren would be similar to the present conditions. However, the levees could be developed to provide wildlife habitat for a few species such as birds and rabbits. The levees would limit the view of nearby residents but would have the advantage of screening the unsightly ditch that is present.

Floodways along Flat Rock Creek would require several hundred acres of agricultural land for levee construction, borrow areas, and the floodway. Sediment deposition would be increased into Hollis Lake from the levees and borrow areas. The confinement of all flows to the area between the levees would drastically change the ecological balance along lower Flat Rock Creek. The cost of this alternative was not estimated because of the environmental effects and the large amount of land that would be required.

Alternative (5) involves the proposed construction of a recreational development at Hollis Lake. This was recommended by the U. S. Bureau of Sports Fisheries and Wildlife. This alternative should not be considered as a substitute for the recreational development at Structure Number 1 but rather as an addition to the plan. The development at Hollis Lake could include nature trails near the shoreline and through the wooded swamp, the development of a green-tree reservoir to attract waterfowl, picnic areas, and boating facilities. The shallowness of the water in the lake would limit its development as a desirable fishery. Mosquitoes and snakes would deter the use of the area during certain seasons and certain times of the day unless special controls were employed. The nature trails would provide a wide variety of plants and animals along the shore and through the wooded swamp. The cost of the alternative would depend on the intensity of the development and the financial support of the sponsors. This alternative could be developed at any time without affecting the functions of the proposed project.

Alternative (6) of no project would include the continuation of the ongoing land treatment program. Some of the land treatment practices would be applied in the upland part of the watershed. Proper grassland and hay management would be encouraged and some of the land unsuitable for cultivation would be converted to permanent vegetation. Conservation land treatment practices in the flood plain would continue with little change. Some relief from flood damage might result from individual or group efforts in installing small levees and drainage ditches. Urban flooding in Van Buren would likely increase and become more damaging as more land in the Town Branch watershed is urbanized. This would result from increased surface water runoff and higher peak flood flows. The City of Van Buren might do some work on Town Branch to improve its appearance and carrying capacity without outside financial aid. Some method of reducing flooding in the industrial development area would probably be installed because the area is ideally located for this purpose except for the flood hazard.

WORKS OF IMPROVEMENT TO BE INSTALLED

Land Treatment Measures

An effective conservation program is necessary for a sound program of watershed protection and flood prevention. The basic objectives of the conservation program are the use of each acre of land within its capabilities and treatment with conservation practices, in accordance with its needs for production and improvement in the proper use. The land treatment measures already installed (Table 1A) show that watershed landowners and operators are currently utilizing conservation practices in their farming operations.

During the 5-year project installation period, emphasis will be placed on the acceleration of the program currently being conducted by the conservation district. The land treatment practices which will be installed constitute the only planned measures for protection of the upland areas. These measures will improve soil and cover conditions, reduce runoff, and reduce the volume of sediment delivered to the floodwater retarding structures.

The acres to be treated and the estimated cost of the land treatment measures to be installed are given in Table 1. These measures will be established and maintained at the expense of individual owners and operators. Land treatment measures are planned for 2,850 acres of cropland and consist of conservation cropping systems, contour farming, and crop residue management.

About 4,500 acres of grassland will receive land treatment measures and practices, including pasture and hayland planting, pasture and hayland management, brush management, deferred grazing, and proper grazing use.

Wildlife habitat management is planned for about 230 acres to improve the cover conditions and increase the food supply for upland game. Wildlife wetland management is planned for 650 acres in the watershed.

Fish and wildlife development will be an important part of conservation plans of cooperators of the Crawford County Conservation District. Fish pond management in farm ponds, stocking with fish and management of the two structures, management of the upland game habitat, recreational developments, and food patches for wildlife will all receive timely attention.

Structural conservation practices, supplementary to the soil and cover improving measures, will include 7,000 feet of diversions, 3,500 feet of terraces, 300 acres of land smoothing, 4,000 feet of drainage mains and laterals, 5,000 feet of drainage field ditches, five structures for water control, and 25 farm ponds.

To accelerate the planning and establishment of the land treatment phase of the project, $19,000 of Public Law 566 funds for technical assistance will be provided in addition to that which is presently available. About $2,500 of Public Law 566 funds will enable standard soil surveys to be completed on 10,000 acres of the watershed. It is estimated that 9,000 acres will be mapped with funds from the going program.

The forest land treatment measures are proposed in order to effectively reduce runoff and erosion. Proper forest management and protection will produce, under each managed stand, a well-developed layer of humus which will improve the soil's basic infiltration rate and water-storage capacity. Favoring humus-building tree species along with game food-bearing and den trees during cutting operations and interplanting with the same or similar species will not only assure the development of well-aggregated soils and maintain an effective litter and humus layer but also accelerate the development of a varied and productive wildlife habitat. An aggressive fencing program is proposed to protect existing and future forest stands from further grazing destruction; tree planting and stand improvement operations will not be performed unless the tract is protected from grazing.

Accelerated technical assistance to the landowners in the watershed will result in effective forestry practices being applied to the forest lands. In harmony with sound watershed management, forest lands will be managed to fulfill wildlife, recreation, timber, and other environmental requirements. Forest management goals will be directed to attain the most desirable forest succession type.

The primary use on about 300 acres of woodland on 18 farms is being designated as wildlife land by their owners. The conservation district and the Arkansas Forestry Commission plan to work closely in developing a forest land treatment program that will most effectively establish and maintain forest wildlife habitat.

The planned forest land treatment measures include about 900 acres of noncritical tree planting, 1,900 acres of stand improvement, and fire prevention measures for all the forested lands.

(1) Tree Planting - Watershed Protection (900 acres) - Reforestation of 900 acres of understocked stands is required not only to adjust land use up to its capability but also to reduce runoff and erosion by producing a protective forest canopy and an absorbent forest floor of a spongy humus layer under a protective layer of litter.

(2) Stand Improvement Measures (1,900 acres) - These are silvicultural measures designed to improve the forest's hydrologic capabilities by adjusting the stand composition which will produce the optimum development and protection of forest cover, litter, and humus. These practices include improvement cuttings, tree release, inferior species and cull removal, and others.

Projected urban and industrial development will create an erosion and sediment problem over and above that expected for an agricultural watershed unless special erosion control measures are applied by builders during construction. Some measures that may become necessary are temporary debris and desilting basins, seeding and mulching exposed soil, temporary diversion of runoff, forested buffer zones, infiltration zones, and sediment-trapping areas. These special measures do not preclude protection and management of existing woodland within the urban influence before, during, and after development. Urban land treatment measures involve 400 acres undergoing urban development, 1,600 acres already in urban development, and 80 acres of forest land. Projections indicate that about 80 acres of forest land will be converted to urban use during the installation period.

Areas disturbed by project construction will be promptly revegetated with plants of maximum value to wildlife for food or cover or both in the form of grasses, forbs, shrubs, and trees, whichever is the most effective in the long run.

Structural Measures

Structural measures consist of one multiple purpose structure (flood prevention and recreation), one floodwater retarding structure, and approximately 7.4 miles of channel work (see Project Map, Figure 4).

The installation of structural measures will require the relocation of one family (two people) from an owner-occupied dwelling on Floodwater Retarding Structure Number 2. The installation will not require the relocation of any business or farm operation.

The total estimated installation cost for the structural measures is $4,420,550.

The total drainage area above the proposed dams is 5.53 square miles, representing 19 percent of the entire watershed.

The two structures have an aggregate storage capacity of 2,301 acre-feet. Floodwater storage is 1,943 acre-feet. Recreation storage is 109 acre-feet. Sediment storage which provides for 100-year accumulation is 249 acre-feet.

Multiple Purpose Structure Number 1, which is being built in cooperation with the City of Van Buren, Arkansas, will provide for 109 acre-feet of storage for recreation in addition to 37 acre-feet of submerged sediment which is expected to accumulate during the 100-year life of the structure. An additional 2 acre-feet of sediment is expected to accumulate in the flood pool. Floodwater detention storage is 152 acre-feet or 8.0 inches, expressed in inches of runoff from the drainage area above the structure.

The recreation pool will have a surface area of 11 acres. An additional 9 acres will be subject to temporary inundation by the floodwater pool. Multiple Purpose Structure Number 1 is located in the Van Buren City Park and will be open to the public. Adequate sanitary facilities are available at the present time.

The principal spillway crest elevation of Floodwater Retarding Structure Number 2 was set at the 100-year submerged sediment level with an ungated port at the 50-year submerged sediment level to augment flow downstream. The submerged sediment expected to accumulate during the first 50 years is 102 acre-feet and 94 acre-feet during the second 50-year period. An additional 14 acre-feet of sediment is expected to accumulate in the flood pool. The 50-year sediment pool will inundate 20 acres. Eleven acres covered by the second 50-year sediment pool for augmentation release will be subject to long periods of inundation and an additional 114 acres will be subject to temporary inundation by the flood pool. Floodwater detention capacity is 1,791 acre-feet or 6.48 inches expressed in inches of runoff from the drainage area above the structure.

Both structures will have principal spillways consisting of a two-stage concrete riser with a reinforced concrete conduit through the fill. A drain valve will be included in the principal spillway to facilitate the installation of the dam by disposal of runoff during construction and to drain the impoundment as needed for repairs. A mid-level gate will be installed to provide for manipulation of water levels for aquatic weed control, fish management operation, exposure of shallow edges for waterfowl plantings, and the means to provide water downstream for emergency use. The dams will be earthfill structures which consist of a cohesive core material, a rock shell, and an intervening filter of graded material. Adequate borrow material will not be available in the pool areas and approximately 11 acres of offsite borrow on Structure Number 1 and 18 acres on Structure Number 2 will be required for the embankments. These areas are expected to supply about 115,000 cubic yards on Structure Number 1 and 298,000 cubic yards on Structure Number 2. Suitable borrow areas are located about one-quarter mile downstream and also one-quarter to one-half mile north of Structure Number 1. All of the offsite borrow material needed on Structure Number 2 can be obtained from the flood pool area immediately above the sediment pool.

The emergency spillway on Multiple Purpose Structure Number 1 is on the left abutment and on Floodwater Retarding Structure Number 2, it will be in a topographic saddle above the left abutment. Both of the emergency spillways will be vegetated and will release runoffs, exceeding the reservoir storage, away from the embankment.

Timber from cleared areas will be disposed of in compliance with state laws on pollution where burning is necessary. Where burning is not necessary, the timber will be piled to enhance the wildlife habitat.

All construction areas will be managed to minimize onsite erosion and sediment production, and sediment traps will be constructed below erosive areas to catch construction-related sediment.

All earthfills, emergency spillways, and offsite borrow areas will be revegetated immediately after construction. Most of the revegetation will be with grasses and legumes and will include woody and herbaceous plants for landscaping and wildlife habitat. Vegetated areas will be fenced where needed to protect vegetation.

The present land uses of the embankment and emergency spillway, offsite borrow, and pool areas for each structure are as follows:

Structure	Land Use		
	Grassland (Acres)	Woodland (Acres)	Urban & Built-up (Acres)
Number 1			
Embankment & Emergency Spillway	0	0	6 2/
Permanent Inundation	0	0	11 2/
Temporary Inundation 1/	0	0	9 2/
Offsite Borrow	0	0	11 3/
Number 2			
Embankment & Emergency Spillway	12	8	0
Permanent Inundation	20	11	0
Temporary Inundation 1/	100	14	0
Offsite Borrow	18	0	0

1/ Land use is not expected to change in the temporarily inundated flood-pool area.
2/ Van Buren City Park which is in forest vegetation.
3/ Located outside the city park.

All applicable state and local laws will be complied with in the design and operation of these structures. Guidelines for the U. S. Public Health Service will be used in the design of watershed features to minimize vector problems related to project installation.

Work on Channel Number 1 (Town Branch) will consist of 1.0 mile of clearing and removal of loose debris and 3.2 miles of channel work. The clearing and debris removal will consist of incidental clearing and debris removal

to insure the design capacity. The channel work will increase the capacity of the channel to provide full protection for the urban area for the 100-year storm. The channel work consists of increasing the depth and/or width of the existing channel. Reinforced concrete-lined channel will be utilized through the residential area of Van Buren to reduce the necessity for encroaching upon high-value residential property.

Work on Channel Number 2 (Flat Rock Creek) will consist of 3.2 miles of debris removal and clearing in restricted areas to provide an adequate capacity to carry the approximate 1-year peak discharge.

Channels will be worked from one side and the spoil will be spread. Spoil that may remain after construction of the concrete-lined channel through the urban area of Van Buren will be hauled from the area. Channel banks will be seeded within 24 hours after excavation and the spoilbanks and berms will be vegetated immediately after shaping. Vegetative material along the channels will include woody and herbaceous plants for landscaping and wildlife habitat. Channel construction contracts will be completed in early spring, when feasible, to provide a full growing season immediately following construction.

Approximately 16 water-control structures (pipe overfall structures) will be installed as appurtenances to the channel work in side drains where needed for grade stabilization, erosion control, and to facilitate inspection and maintenance.

Access roads for maintenance will be provided by smoothing the berm or spreading spoil along one side of each channel to permit travel by maintenance equipment.

Studies of the earth channel sections indicate that stability from the standpoint of runoff flow will not be a problem. Both channels contain no appreciable bedload. Bedrock will not be encountered in any of the planned excavation. Channel bank and bottom materials on Channel Number 1 were sampled at thirteen locations and analyzed for size distribution and plasticity. The materials are nonplastic to slightly plastic with plasticity indexes ranging from 0 to 8; D_{75} sizes range from 0.175 mm to 0.54 mm. Of the thirteen samples, two are classified as ML, seven are SM, and four are SP. Based on the permissible velocities procedure in Technical Release 25, the lowest computed allowable velocity of 1.9 feet per second will not be exceeded.

A changed condition in the ground-water table could present a stability problem during the construction of Channel Number 1. The problem is created by the elevated water table created by Lock and Dam 13 on the Arkansas River. Preliminary studies, investigations, and information supplied by the Corps of Engineers and the U. S. Geological Survey indicate that the water table will be slightly above the ele-

vation of the bottom of Channel Number 1. An estimate of the rate of return flow into the channel is 15 cfs. This volume of water is not significant, but the SM and SP material which would have to be excavated will be completely saturated resulting in a possible bank stability problem. Therefore, the depth of excavation on Channel Number 1 will be limited to elevation 392.0 feet mean sea level to minimize seepage from the Arkansas River. This revised design would allow the phreatic line of the water table to slope toward the channel and would intersect the channel at grade. Stability is not expected to be a problem once vegetation on the banks is established.

More detailed information on quantities, costs, and design features is given in Tables 1, 2, 2A, 3, 3A, and 3B.

Other Measures

The Arkansas Archeological Survey's reconnaissance of the watershed in the areas to be directly affected by the structural measures resulted in the identification of nine sites, three of which were historic and six that were prehistoric.

One prehistoric site will be inundated by the sediment pool of Floodwater Retarding Structure Number 2 and one historic site will be adversely affected by channel work along Town Branch. The Arkansas Archeological Survey will be requested to make additional investigations after areas have been cleared for construction.

The Secretary of the Interior and the State Historic Preservation Officer will be notified of the sites and the Secretary of the Interior will be requested to undertake the recovery, protection and preservation of data, as needed.

EXPLANATION OF INSTALLATION COSTS

The total installation cost of the project is estimated to be $4,678,710 of which $3,609,671 will be paid from Public Law 566 funds and $1,069,039 will be borne by other funds. Included in the total costs are $258,160 for land treatment measures and $4,420,550 for structural measures.

Land treatment costs will be shared $31,200 by Public Law 566 funds and $226,960 by other funds. Public Law 566 funds will provide $6,500 for technical assistance to accelerate the installation of land treatment measures on all lands other than forest land and $2,500 for soil surveys. Other funds will include $5,500 for technical assistance and $2,500 for soil surveys through the regular program of Public Law 46.

The costs of installation of the forestry phases of the private land treatment program were developed by the U. S. Forest Service and the Arkansas Forestry Commission. The technical assistance costs were based

on the present costs of the going Cooperative Forest Management Program. Installation costs are based on present prices being paid by landowners or operators to establish similar measures in the locality. The private forest land treatment measures needed to meet treatment goals were developed from the field survey of the watershed and were adjusted for expected landowner participation during the installation period.

The estimated cost of the forest land treatment program is $118,060. Of this amount, $22,200 are Public Law 566 funds and $95,860 are from other sources. The Public Law 566 funds provide 80 percent of the cost for accelerated technical assistance and the fire prevention contactor program. The Arkansas Forestry Commission will provide 20 percent or $6,900.

The going cooperative Forest Management Program will provide additional technical assistance valued at $60. The going Cooperative Forest Fire Control Program will provide additional assistance for the protection of the watershed through capital outlay acceleration valued at $1,800 during the length of the installation period.

The landowners and operators will furnish the $87,100 required for the installation of the forest land treatment measures on their land.

The Use of Facilities Method was used to allocate joint costs between purposes in Multiple Purpose Structure Number 1. This resulted in an allocation of 63.67 percent to flood prevention and 36.33 percent to recreation. The City of Van Buren, Arkansas, will bear 50 percent of the construction cost allocated to recreation and all costs of obtaining land rights. Public Law 566 funds will bear 50 percent of the construction cost allocated to recreation, all of construction cost allocated to flood prevention, and all of the engineering services cost.

All costs of Floodwater Retarding Structure Number 2 and all channel work were allocated solely to flood prevention. Public Law 566 funds will bear all construction costs and engineering services costs. The Flat Rock Creek Improvement Project Area of the Crawford County Conservation District, Crawford County, Arkansas, will bear all costs of obtaining land rights.

The total installation cost of structural measures will be shared $3,578,471 by Public Law 566 funds and $842,079 by other funds. The cost sharing responsibility results in the following distribution of costs.

Construction costs estimated at $2,838,373 will be shared $2,792,363 by Public Law 566 funds and $46,010 by the City of Van Buren. Construction costs include such items as clearing, excavation, debris removal, spoil spreading, earthfills, concrete principal spillways and lined channels, and vegetation of disturbed areas.

Public Law 566 funds will provide all engineering services costs, estimated to be $252,836, which includes the direct cost of engineers and other technicians for surveys, designs, and preparation of plans and specifications for structural measures.

Relocation payments were estimated to be $3,000. These are Public Law 566 and other costs associated with the requirements of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970. Relocation payments are applicable to a displaced person, business, or farm operation. The estimated payments include moving and related expenses for any displaced person, business, or farm operation as well as financial assistance for replacement housing for any displaced person who qualifies and whose dwelling is acquired because of the project. Relocation payments will be shared 77.2 percent by Public Law 566 funds and 22.8 percent by other funds. The cost sharing is based upon the ratio of Public Law 566 funds and other funds to the total project cost, less relocation payments. This results in cost sharing $2,316 by Public Law 566 funds and $684 by the Flat Rock Creek Improvement Project Area of the Crawford County Conservation District.

The sponsor will provide, without Public Law 566 cost sharing, relocation assistance advisory services to those persons being relocated as a result of the project. The costs of these services are estimated to be $1,000.

Project administration costs are estimated to be $552,941. These are Public Law 566 and other administrative costs associated with the installation of the structural measures. This includes costs of contract administration, government representatives, relocation assistance advisory services, necessary inspection during construction to insure that measures are installed in accordance with plans and specifications, and other administrative costs. These costs are treated as project costs, but will not be considered as applicable to individual purposes served by the project nor are they a part of the cost of individual measures. Public Law 566 funds will provide $252,837 for construction inspection, $252,837 for other administrative costs, and $25,232 for contract administration. The City of Van Buren will pay an estimated $2,297 for administrative cost, and the Flat Rock Creek Improvement Project Area of the Crawford County Conservation District will pay about $18,688 for administrative costs and about $1,000 for relocation assistance advisory services. Relocation assistance advisory services include such items as: (1) determining needs, (2) obtaining current pertinent information concerning housing programs, costs, etc., (3) developing and distributing brochures, (4) assuring replacement dwellings, and (5) assisting in getting established.

The City of Van Buren will provide land rights costs estimated to be $63,000 for Multiple Purpose Structure Number 1. This includes $20,000 for modification of utilities.

All other land rights costs estimated to be $640,400 will be provided by the Flat Rock Creek Improvement Project Area of the Crawford County Conservation District. This includes $195,700 for land, easements, and

rights-of-way, $210,000 for the reconstruction and modification of two structures under the Missouri-Pacific Railroad, $115,600 for road and bridge modification, $10,000 for additional cost of closed conduit under the parking lot at Nation's Drive-In, $38,100 for utility line modification, $31,000 for modification of three buildings, and $40,000 for fencing along the concrete-lined channel where needed for the protection and safety of the public.

The National Park Service will provide funds, estimated at $70,000 for the salvage of two archeological sites that will be affected by the project. This cost includes $47,000 for salvage of one prehistoric site in Floodwater Retarding Structure Number 2 and $23,000 for salvage of one historic site along Channel Number 1.

Construction cost estimates were based on computation of quantities derived from survey data using unit costs of similar work on other projects.

The engineer's cost estimate and contingency allowance of 12 percent is considered realistic and provides a reasonable allowance for unexpected costs.

The estimated schedule of obligations for the 5-year project installation period covering the installation of both land treatment and structural measures is as follows:

SCHEDULE OF OBLIGATIONS

Fiscal Year	Measures	Public Law 566 Funds (dollars)	Other Funds (dollars)	Total (dollars)
First	Land Treatment Measures	5,200	31,500	36,700
	Engineering Services	80,500	-	80,500
	Land Rights Cost	-	119,000	119,000
	Archeological Salvage	-	70,000	70,000
Second	Land Treatment Measures	6,000	43,000	49,000
	Engineering Services	69,000	-	69,000
	Construction: Multiple Purpose Structure Number 1	207,277	46,010	253,287
	Construction: Channel Work	690,000	-	690,000
	Land Rights Cost	-	500,000	500,000
Third	Land Treatment Measures	6,000	43,000	49,000
	Engineering Services	69,000	-	69,000
	Relocation Payments	2,316	684	3,000
	Construction: Floodwater Retarding Structure Number 2	391,000	-	391,000
	Construction: Channel Work	920,000	-	920,000
	Land Rights Cost	-	84,400	84,400
Fourth	Land Treatment Measures	8,000	60,000	68,000
	Engineering Services	34,336	-	34,336
	Construction: Channel Work	584,086	-	584,086
Fifth	Land Treatment Measures	6,000	49,460	55,460
Subtotal		3,078,715	1,047,054	4,125,769
Project Administration		530,956	21,985	552,941
TOTAL		3,609,671	1,069,039	4,678,710

This schedule may be adjusted from year to year on the basis of any significant changes in the plan found to be mutually desirable and in the light of appropriations and accomplishments actually made.

EFFECTS OF WORKS OF IMPROVEMENT

Flood Prevention, Erosion and Sediment

Installation of the combined land treatment and structural measures will provide benefits to about 1,030 acres of flood plain land. Direct flood prevention benefits will accrue to the owners and operators of 30 farms and about 167 urban properties. This includes 16 commercial properties, 4 industrial properties, and 147 residential properties. The area inundated by the 100-year frequency flood will be reduced from 1,030 acres to 658 acres. This is a reduction of 372 acres or 36 percent. The average annual area flooded in the watershed will be reduced 76 percent, from 766 acres to 181 acres.

The benefited area is composed of two separate units: (1) Flat Rock Creek, 726 acres; and (2) Town Branch, 304 acres. The benefited area of Flat Rock Creek is primarily agricultural land. The Town Branch unit contains, in addition to agricultural land, about 62 acres of urban properties in Van Buren, Arkansas.

Due to the diverse nature of the Flat Rock Creek and Town Branch units, the level of protection and the general effectiveness of the project also differs. The following table provides a comparison of the "without project" and "with project" average annual area flooded and the percent reduction by reaches for each unit:

Reach Number	Location	Average Annual Acres Flooded: Without Project	Average Annual Acres Flooded: With Project	Percent Reduction
	Town Branch Unit			
I	Hollis Lake to Missouri-Pacific Railroad	174	3	98
II	Missouri-Pacific Railroad to Structure Number 1	39	0	100
Subtotal		213	3	99
	Flat Rock Creek Unit			
III	Hollis Lake to Interstate 540	396	135	66
IV	Interstate 540 to Missouri-Pacific Railroad	119	41	66
V	Missouri-Pacific Railroad to Structure Number 2	38	2	95
Subtotal		553	178	68
TOTAL		766	181	76

The 100-year frequency flood on the Flat Rock Creek unit will be reduced from 726 acres to 544 acres or 25 percent by installation of the project. The project will reduce the probability of a major flood from 50 percent to approximately 14 percent. The one-year frequency storm, which presently inundates 225 acres, will be reduced to only 19 acres. The average annual area flooded on Flat Rock Creek will be reduced 68 percent from 553 acres at present to 178 acres with the project.

Installation of the project will virtually eliminate the flooding and damages that occur in the Town Branch unit. Urban flooding by the 100-year frequency storm will be reduced from 62 acres to 14 acres, a reduction of 78 percent. Whereas this size storm presently damages 167 residential and commercial establishments, only 12 properties will receive damage with the project installed. The properties to receive damage after the project is installed include one industrial property and eleven residential properties. Damage from the 100-year frequency storm will be reduced 99 percent, from $740,000 to $5,200. The average annual urban damage will be reduced 99.6 percent. The urban area subject to flooding is shown on the Urban Flood Plain Map, Figure 3.

The agricultural segment of the Town Branch unit, Reach I, will receive a 100-year level of flood protection on 148 acres or 61 percent of the present flood plain. The point where flooding begins will be reduced from the present 400-percent chance storm to approximately the 6-percent chance with the project, and average annual flooding will be reduced 98 percent.

The April 1964 flood, an approximate 25-year frequency storm, would have been reduced 47 percent in area inundated, and the total damage from this storm would have been reduced 96 percent. Damages from this size storm would be reduced from $501,400 to $20,000. Urban damages in Van Buren would be reduced about $413,000. The total reduction in damage of about $481,400 for this size flood represents a benefit of about $60 for each of the 8,000 watershed residents. The variation between the reduction in area inundated and reduction in damages results from the high level of protection provided in the urban area where 83 percent of the watershed flood damages occur.

The watershed project will help alleviate the remaining drainage problems in the watershed in two ways: (1) the project will decrease peak flows, thereby improving the outlet for farm drainage; and (2) the land treatment phase of the project includes mains and laterals, field ditches, land smoothing, etc.

Flood protection provided by the project will allow farmers to intensify farming operations in the protected area by using conservation cropping systems, including crop rotations. A two-crop system of small grains followed by soybeans and increases in acreages of vegetables and alfalfa are expected where flooding is reduced.

Timely planting and harvesting of crops will produce higher yields with improved quality. Production costs will be decreased because of efficient planting operations and weed and insect control.

Agricultural enhancement benefits will be realized as a result of the project. The flood plain operators have indicated that with adequate protection against flooding, higher value uses will be adopted and greater amounts of fertilizer and other production inputs will be utilized. Benefits will be realized in the form of increased net income from the farming enterprises. Changed and intensified land use is expected to occur on about 111 and 312 acres, respectively, of the flood plain.

A 100-year level of protection will be provided to about 330 acres of urban land. This protection will greatly enhance the potential for industrial development.

About 80 acres of the flood plain south of Van Buren are planned to be converted from cropland to industrial use. The land has been in the industrial park for some time but continued flooding has prevented its development. These enhancement benefits were estimated to be $66,000 annually.

Application of conservation land treatment measures and the planned forest land treatment measures will markedly reduce the runoff, erosion, and sediment in the watershed and will also enhance recreation, wildlife, and wood-production values. Well-managed forests will contribute significantly to the aesthetic and environmental aspects of living in the watershed.

Conservation land treatment measures in the uplands, particularly proper grazing of grasslands and restricted grazing of woodlands, in addition to wildlife habitat development, will significantly add to the wildlife population.

Sheet erosion will be reduced 32 percent to an average annual rate of 1.5 tons per acre. Sediment deposition in Hollis Lake from the watershed will be reduced from 1,350 acre-feet to 788 acre-feet resulting in a reduction of 42 percent or 562 acre-feet during the life of the project.

Sediment yield will temporarily increase during construction but sediment traps will contain the bulk of this sediment. The project when installed will, through the combined program of land treatment and structural measures, reduce the sediment yield to 7.5 acre-feet per year. This project will extend the life expectancy of Hollis Lake about 40 years.

Lesser amounts of fertilizer, pesticides, and herbicides will be removed from the areas where flooding and erosion are reduced. Pionke and Chesters concluded that, "downstream loss of the absorbed pesticide can

be prevented by controlling erosion from croplands or trapping the 'host' sediment." (J. Environ. Quality, Vol. 2, No. 1, 1973, pg. 41) Nitrate nitrogen moves freely with the water in the soil. The movement of nitrogen into the ground water will be reduced by shortening the duration that floodwater remains on the soil.

Parker (Crops and Soils, Nov. 1972, pg. 10) states that, "Since nearly all phosphate is bound severely in the soil, about the only way to lose it is by removal of the soil. Thus, erosion presents the greatest potential for loss of phosphate. The obvious solution is management that prevents erosion."

Onfarm drainage will be improved by the installation of mains, laterals, field ditches, and land smoothing under land treatment measures. All of the flood plain will have improved drainage because of reduction in floodwater and improved drainage systems that will be installed on areas where flooding frequency is reduced.

The 25 farm ponds to be constructed as part of the land treatment measures will provide fishing and recreational resources to local residents.

Fish and Wildlife and Recreation

Structure Number 2 will have 31 surface acres and the ungated orifice will provide a prolonged low flow in Flat Rock Creek. The low-flow augmentation feature will result in more running riffle areas during normal dry periods. This will stabilize habitat for fish species such as riffle darters and stonerollers. A continual inflow of oxygenated water will help insure a continual level of dissolved oxygen within the tolerances of adapted stream organisms within the pools.

During periods of extended drought, the storage set aside for the low flow will be depleted and the device will cease to flow. As sediment accumulates above the orifice outlet, the storage will be depleted and the flow will cease more often. The trend, however, will be toward the natural or present condition. When the low flow and evaporation lower the water level to below the orifice, subsequent inflow would have to raise the water level back up to the orifice before outflow would occur.

During the period when the clearing and debris removal is being accomplished the fishery habitat will be temporarily disturbed but it will recover when the construction is completed.

Environmental effects will also be realized in the lower portion of the watershed by prolonging the life of Hollis Lake by about 40 years. The wooded swamp which surrounds Hollis Lake will continue to be an excellent wetland habitat. Sediment delivered to the lake will be reduced 42 percent and the long-term average annual sediment concentration will be reduced 44 percent.

The 11-acre recreational lake at Multiple Purpose Structure Number 1 will be used intensively and will add to the living quality of the area. Approximately 200 people will use the lake on peak use days. The following tabulation shows the projected annual use of the recreational water and surrounding area:

Recreational Use	Visitor-Days per Year
Sightseeing	6,000
Fishing	800
Picnicking	3,000
Boating	500
Frog Gigging	50

The aesthetic and scenic values in the watershed will be improved by converting the present unsightly ditch through Van Buren to one that is landscaped and designed for aesthetic values. Landscaping of the areas around the two structures will also improve the aesthetic and scenic value.

Archeological, Historic, and Scientific

One prehistoric site and one historic site will be adversely affected by the project. Archeological sites may be partially damaged during salvage operations and sites that have not been located may be totally destroyed during construction.

Economic and Social

The project will serve as an immediate stimulus to the local economy by providing new employment opportunities. The employment multiplier was used to measure the total effect of creating additional employment. The multiplier was derived from the occupational classifications of the employed labor force. Basic data for estimating the number of jobs created by the project were obtained from OBERS projections and from U. S. Census of Population, Arkansas 1960.

The analysis indicates that 80 new jobs will be created by providing employment opportunities for local labor during the construction period. Also, there will be 95 new jobs, associated with basic and derivative industries, that will continue after construction is completed.

This effect of the project is particularly significant due to the high rate of unemployment and underemployment in the local area. The use of local labor for operation and maintenance of the project will provide a continuing favorable effect on the local economy. Loss of agricultural production in the pool area will cause a minor loss of agricultural income.

Additional income will be received by the laborers employed during construction and by farmers from the increased sales of farm products as a result of damage reduction and agricultural enhancement. The increased

purchase of items or services required to produce and market the expanded production represents new income to local farm supply dealers, transporters, and processors. The urban enhancement resulting from flood protection will provide landowners, developers, building material suppliers, and laborers with added income.

The new income will generate additional consumer expenditures for basic necessities, items which improve their standard of living, and other goods and services. These expenditures will initiate a chain of spending whereby each successive recipient spends a portion of the amount received. Business activity in other sectors of the local economy will increase as this new income is spent and respent. Also, more employment opportunities will be provided in these sectors.

The improved economic climate will enable the community to better support new or improved schools, parks, roads, health facilities, and other public projects that will add to the enjoyment of life.

Knowledge of the protection afforded by the project will give the residents a greater sense of security. Families can offer their children greater incentives to continue their education and remain in the community.

The various effects of the project will contribute to the economic goals of the Arkansas Valley Resource Conservation and Development Project, the Crawford County Development Council, the Western Arkansas Planning and Development District, and the Ozarks Economic Development Region.

In essence, the project will have an impact on the economic growth and development in the region.

Travel within the City of Van Buren will be temporarily disrupted; this will involve detours of a few blocks during the construction of the concrete-lined channel.

Certain social adjustments will be required of the family that is to be relocated due to project measures. The impact of these adjustments will be minimized with help and understanding from the local sponsors. A comparable replacement dwelling giving full consideration to the desires and needs of the family involved, will make the adjustments minor and period of adjustment short.

PROJECT BENEFITS

The total estimated benefits accruing to the structural measures included in this plan amount to $364,910 annually. Of these benefits, $180,830 are damage reduction, $10,160 are agricultural enhancement, $66,000 are urban enhancement, $10,350 are recreation, $24,700 are redevelopment, and $72,870 are secondary.

The general location of the damage reduction benefits attributed to the combined project of land treatment and structural measures is presented in the following tabulation:

Reach Number	Location	Average Annual Damage Without Project (dollars)	Average Annual Damage With Project (dollars)	Reduction (percent)
I	Hollis Lake to Missouri-Pacific Railroad	4,230	60	98
II	Missouri-Pacific Railroad to Structure Number 1	166,480	660	99
III	Hollis Lake to Interstate 540	13,960	4,930	65
IV	Interstate 540 to Missouri-Pacific Railroad	4,060	950	77
V	Missouri-Pacific Railroad to Structure Number 2	550	20	96
Total		189,280	6,620	97

The damage reduction benefits include $1,830 that are attributable to the installation of the land treatment measures. These benefits were excluded from those used in project justification.

The reduction in frequency and depth of flooding will enable the farmers to increase their net farm income an estimated $10,160 annually. These benefits are accounted for by changed land use, $5,480, and more intensive land use, $4,680. The agricultural enhancement benefits were discounted to allow for the appropriate lag in accrual.

It is anticipated that urban enhancement benefits arising from the conversion of agricultural land to industrial uses will amount to $66,000 annually. These benefits are based on the increase in value of the land from its present use to its potential use, less the associated development costs. These benefits will accrue only on the area protected from the 100-year frequency flood.

The benefits which will result from the recreational use of Multiple Purpose Structure Number 1 are estimated to amount to $10,350 annually.

Crawford County's eligibility under the Public Works and Economic Development Act of 1965 as an area of low income and high unemployment was the basis for

claiming redevelopment benefits. Benefits of about $24,700 will accrue annually from the use of local unemployed and underemployed labor in the construction and operation and maintenance of the project.

Secondary benefits attributable to the project are estimated to be $72,870 annually. These benefits represent the effect of the initial and successive rounds of spending made possible by the additional income created by the project. These benefits are based on additional income from employment of local laborers during construction and for operation and maintenance; the sales of greater quantities of farm products or products having higher values; the increased sales of local farm supply dealers, transporters, processors, etc., who provide production inputs or other items or services required to produce and market the increased quantity of goods; and the income generated in other sectors of the local economy by the increased business activity as this new income is cycled through the economy. These benefits are not based on indirect benefits, contain no duplication of other benefits, and are adjusted to account for the portion of the new income spent outside the local area.

COMPARISON OF BENEFITS AND COSTS

The average annual cost of structural measures, including the amortized installation cost plus operation and maintenance, is $261,990. Installation of these structural measures will result in estimated average annual benefits of $292,040, excluding those from secondary sources. The ratio of these annual benefits to the annual cost is 1.11 to 1.

The total benefits, including secondary, attributable to the structural measures are $364,910 annually. These benefits amount to an annual return of $1.39 for each dollar of cost (Table 6).

PROJECT INSTALLATION

The watershed project is planned for a 5-year installation period. Land treatment measures will be established throughout the entire period by landowners and operators, in cooperation with the local conservation district. The district, with additional help from the Soil Conservation Service, and the Arkansas Forestry Commission, in cooperation with the U. S. Forest Service, will assist with the planning and application of these measures. This assistance will be accelerated to assure application of planned measures within the project installation period. The Soil Conservation Service will provide the additional technical assistance for conservation planning, land use determination, application assistance for cropland, pastureland, rangeland, and wildlife land practices.

The Arkansas Forestry Commission, in cooperation with the U. S. Forest Service, will provide assistance to landowners and others for determining and planning the necessary land treatment practices for forest lands. Landowners will be encouraged to apply and maintain accepted forestry measures on their woodland.

The U. S. Forest Service, by and through the Arkansas Forestry Commission, will provide the extra technical assistance necessary to accelerate the installation of forestry practices. This additional technical assistance is that planned over and above the assistance now provided to landowners under the going Cooperative Forest Management Program. A forester trained in watershed management will be assigned to the project to guide and assist the landowners in the installation of the planned forestry measures.

The Crawford County Conservation District will assume active leadership in establishing the land treatment program. The supervisors of the district, by scheduled meetings and individual contacts, will encourage watershed landowners and operators to establish a complete soil and water conservation program.

The Crawford County Conservation District, through the Flat Rock Creek Improvement Project Area, will be responsible for providing relocation assistance advisory services in connection with relocating the displaced persons from Floodwater Retarding Structure Number 2. These responsibilities include determining the need of displaced persons for relocation assistance; providing current and continuing information on the availability, prices, and rentals of comparable decent, safe, and sanitary housing for sale or rent; assuring that, within a reasonable period of time prior to displacement, replacement dwellings will be available; furnishing information concerning housing programs, disaster loan programs, and other Federal and State programs offering assistance to displaced persons; providing other advisory services to displaced persons in order to minimize hardships to such persons in adjusting to relocation; advising displaced persons that they should notify the sponsors before they move; and prior to initiation of acquisition, providing persons from whom the sponsors plan to acquire land, a brochure or pamphlet outlining the benefits to which they may be entitled.

The sponsor will also be responsible for providing the necessary project administration functions associated with relocating the displaced persons. These responsibilities include providing personally or by first class mail, written notices of displacement; providing appropriate application forms to each displaced person; filing, reviewing, and processing applications for relocation assistance; reviewing and processing grievances in connection with displacements; and making relocation payments. The Soil Conservation Service will assist the sponsor when necessary in fulfilling these administrative responsibilities.

The sponsor has determined that decent, safe, and sanitary replacement housing will be available prior to construction of the project. The sponsor understands that notices must be issued to vacate at least 90 days before the displaced persons are required to move.

The Agricultural Extension Service will assist with the educational phase of the program by conducting general information and local farm meetings;

preparing radio, television, and press releases; and using other methods of getting information to the watershed landowners and operators.

The sponsors will make a concerted effort to interest local landowners in establishing additional wildlife food and cover plants that will benefit quail, deer, rabbit, and dove.

Structural measures will be installed during the second, third, and fourth years of the project installation period.

The Flat Rock Creek Improvement Project Area of the Crawford County Conservation District, Crawford County, Arkansas, and the City of Van Buren, Arkansas, have all of the necessary authority to discharge local responsibility.

The installation of the structural measures will be contingent upon the following conditions:

1. Conservation plans covering 50 percent or more of the lands in the drainage area above each detention reservoir have been developed prior to installation of structural measures.

2. All land rights have been obtained for all structural measures or a substantial part has been obtained and a written statement has been furnished by the Improvement Project Area of the Crawford County Conservation District and the City of Van Buren, Arkansas, that the right of eminent domain will be used, if necessary, to secure the remainder within the project installation period and the sufficient funds are available for this purpose.

3. The City of Van Buren, Arkansas, is prepared to discharge its responsibilities, as set forth in this plan, for installation of Multiple Purpose Structure Number 1.

4. The Flat Rock Creek Improvement Project Area of the Crawford County Conservation District, Crawford County, Arkansas, is prepared to discharge its responsibilities, as set forth in this plan, for installation of Floodwater Retarding Structure Number 2 and all channel work.

5. The project agreements have been executed.

6. The operation and maintenance agreements have been executed.

The Soil Conservation Service has been formally requested to be the contracting agency and will provide all technical assistance in design, preparation of contract payment estimates, final inspections, execution of certificates of completion, and related tasks for the establishment of planned structural measures.

FINANCING PROJECT INSTALLATION

Federal assistance will be provided under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83d Congress, 68 Stat. 666) as amended. This assistance is subject to the appropriation of funds.

The cost of land treatment measures will be financed by landowners and operators with assistance from federal and/or state programs. Public Law 566 funds will be provided for technical assistance to accelerate the installation of land treatment measures. Public Law 566 funds and Cooperative Forest Management Program funds will provide the technical assistance necessary to install forest land treatment measures on private forest lands.

Costs involved in the application of forest land treatment measures, other than those borne by Public Law 566 funds, will be provided by the landowners and operators. Public Law 566 funds will provide for technical assistance necessary to accelerate the installation of these measures.

The Flat Rock Creek Improvement Project Area of the Crawford County Conservation District, Crawford County, Arkansas, has the powers under State law to secure and repay loans, assess benefits, and levy taxes and will provide the local funds needed in the installation of all structural measures except Multiple Purpose Structure Number 1. They have filed a letter of intent to borrow with the Farmers Home Administration, Little Rock, Arkansas.

Funds obtained from this loan will be used to carry out the local obligations in installing the planned structural measures. Relocation assistance advisory services costs and costs for relocation payments will be paid from these funds. Funds for repayment of this loan will be obtained from taxes levied on the benefited area.

The City of Van Buren, Arkansas, will assume the local responsibility for the installation, operation, and maintenance of Multiple Purpose Structure Number 1. A watershed loan will be obtained to finance the local share of the construction cost of this structure. The City of Van Buren owns the necessary land which will be required for Multiple Purpose Structure Number 1 at the present time. Funds for repayment of the loan will be provided by the City Park Commission from their regular source of revenues.

Public Law 566 funds will provide the construction costs and all installation costs incurred by the Soil Conservation Service in the installation of the structural measures.

The National Park Service will provide all funds for the salvage of archeological sites.

PROVISIONS FOR OPERATION AND MAINTENANCE

The landowners and operators will maintain the land treatment measures under agreement with the Crawford County Conservation District. The Arkansas Forestry Commission, in cooperation with the U. S. Forest Service, will furnish the technical assistance necessary for operating and maintaining the forest land treatment measures under the going Cooperative Forest Management Program. They will also continue to furnish fire protection under the Cooperative Forest Fire Control Program.

The Soil Conservation Service will provide the technical assistance necessary for the operation and maintenance of all other land treatment measures.

Representatives of the district and the Soil Conservation Service will make periodic inspections of land treatment measures and the district will encourage landowners and operators to perform needed maintenance.

Multiple Purpose Structure Number 1 will be operated and maintained by the City of Van Buren, Arkansas at an annual cost of $300. All applicable state and local laws will be complied with in the operation of the structure.

Floodwater Retarding Structure Number 2 and all channel work will be operated and maintained by the Flat Rock Creek Improvement Project Area of the Crawford County Conservation District, Crawford County, Arkansas, at an annual cost of $1,100. Funds for paying maintenance costs will be obtained from taxes levied on the benefited area. Maintenance will be performed with contributed labor, district-owned equipment, by contract or force account, or a combination of these methods.

Provision will be made for free access for representatives of the sponsoring local organizations and federal agencies to inspect and for the sponsors to provide maintenance for the structures at any time.

For the first three years after the structures are installed, the Soil Conservation Service and the sponsors will make a joint inspection annually, after unusually severe floods, and after the occurrence of any other unusual conditions which might adversely affect the structural measures. Inspection after the third year will be made annually by the sponsors.

All debris or obstructions that may hamper the function of the structures or channels will be removed immediately and disposed of in a proper manner.

The inspection of Multiple Purpose Structure Number 1 and Floodwater Retarding Structure Number 2 will include, but not be limited to, the condition of the principal spillway and its appurtenances, earth fills, emergency spillways, and fences. Annual maintenance will likely be needed to maintain an adequate vegetative cover on earth fills, vegetative emergency spillways, and borrow areas. During the life of the

structure, it may be necessary to do major repair work to restore concrete that has deteriorated; replace gates, trash racks, or other metal works; remove and/or stabilize slide material, and replace eroded material and revegetate the emergency spillways. Fences will be maintained until there is mutual agreement that they are no longer needed to protect structural works of improvement.

The inspection of the channels, with appurtenances, will be made to determine the need for vegetation control, bank stabilization, or other obstacles which could result in an abnormal reduction in channel capacities. Special attention will be given to the inspection and maintenance of the grade stabilization structures. Annual maintenance may be required to remove debris and to control and maintain proper vegetation. During the life of the channels, it may be necessary to remove silt bars, replace grade stabilization structures, and fill contraction cracks in the concrete-lined channel.

The access roads along the channels will also be maintained for inspection and maintenance of the channels.

The sponsoring local organizations will maintain a record of all maintenance inspections and maintenance performed and have the record available for review by the Soil Conservation Service. They fully understand their obligations for maintenance and will execute specific maintenance agreements prior to the issuance of invitations to bid on the construction of the structural measures.

All work will meet the requirements of Act 81, as amended, of the Arkansas General Assembly of 1957, which authorizes the Division of Soil and Water Resources to issue permits for construction of dams, inspect construction, and make annual operation and maintenance inspections after construction. The sponsors will be required to follow the Division's recommendations on needed maintenance work.

An operation and maintenance agreement will be executed prior to signing a project agreement. This operation and maintenance agreement will contain a reference to the Soil Conservation Service publication, "State of Arkansas Watershed Operation and Maintenance Handbook," and a plan for operation and maintenance of the structural measures will be prepared.

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST

Flat Rock Creek Watershed, Arkansas

Installation Cost Item	Unit	Number to be Applied	ESTIMATED COST (DOLLARS) 1/ Public Law 566 Funds SCS 3/	FS 3/	Total	Other Funds SCS 3/	FS 3/	NPS 3/	Total	Total
LAND TREATMENT										
Land Areas 2/	Acres to									
Cropland	be treated	2,850	-	-	-	20,500	-	-	20,500	20,500
Grassland		4,500	-	-	-	102,600	-	-	102,600	102,600
Forest Land		3,100	-	-	-	-	87,100	-	87,100	87,100
Fire Prevention Contractor Program		4,270	-	9,700	9,700	-	5,200 5/	-	5,200	14,900
Technical Assistance		-	6,500	12,500	19,000	5,500	3,560 6/	-	9,060	28,060
Soil Survey		19,000	2,500	-	2,500	2,500	-	-	2,500	5,000
TOTAL LAND TREATMENT			9,000	22,200	31,200	131,100	95,860	-	226,960	258,160
STRUCTURAL MEASURES										
Construction										
Multiple Purpose Structure Number 1	Number	1	207,277		207,277	46,010	-	-	46,010	253,287
Floodwater Retarding Structure Number 2	Number	1	391,000	-	391,000	-	-	-	-	391,000
Channel Work 4/ (N-3.2) (M-4.2)	Mile	7.4	2,194,086	-	2,194,086	-	-	-	-	2,194,086
Subtotal - Construction			2,792,363	-	2,792,363	46,010	-	-	46,010	2,838,373
Engineering Services			252,836	-	252,836	-	-	-	-	252,836
Relocation Payments	Number	1	2,316	-	2,316	684	-	-	684	3,000
Project Administration										
Construction Inspection			252,837	-	252,837	-	-	-	-	252,837
Administrative Cost			278,119	-	278,119	20,985	-	-	20,985	299,104
Relocation Assistance Advisory Service			-	-	-	1,000	-	-	1,000	1,000
Subtotal - Project Administration			530,956	-	530,956	21,985	-	-	21,985	552,941

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST (Continued)

Flat Rock Creek Watershed, Arkansas

Installation Cost Item	Unit	Number to be Applied	ESTIMATED COST (DOLLARS) 1/ Public Law 566 Funds SCS 3/	FS 3/	Total	Other Funds SCS 3/	FS 3/	NPS 3/	Total	Total
Other Cost										
Land Rights			-	-	-	703,400	-	-	703,400	703,400
Archeological Salvage	Number	2	-	-	-	-	-	70,000	70,000	70,000
Subtotal - Other			-	-	-	703,400	-	70,000	773,400	773,400
TOTAL STRUCTURAL MEASURES			3,578,471	-	3,578,471	772,079	-	70,000	842,079	4,420,550
TOTAL PROJECT			3,587,471	22,200	3,609,671	903,179	95,860	70,000	1,069,039	4,678,710

1/ Price Base: 1974
2/ Includes only areas estimated to be adequately treated during the project installation period. Treatment will be accelerated throughout the watershed and dollar amounts apply to total land areas, not just adequately treated areas.
3/ Federal agency responsible for assisting in installation of works of improvement.
4/ Type of channel prior to project: (N) - an unmodified, well defined natural channel or stream; (M) - manmade ditch or previously modified channel.
5/ Includes $1,800 capital outlay acceleration based on 1956 Area and Cost Review.
6/ Includes $60 from the going Cooperative Forest Management Program.

TABLE 1A - STATUS OF WATERSHED WORKS OF IMPROVEMENT

(at time of work plan preparation)

Flat Rock Creek Watershed, Arkansas

Measures	Unit	Applied to Date	Total Cost (Dollars) 1/
LAND TREATMENT MEASURES			
Conservation Cropping System	Acre	1,600	24,000
Crop Residue Management	Acre	1,600	4,000
Brush Management	Acre	1,600	4,800
Pasture and Hayland Planting	Acre	2,600	78,000
Pasture and Hayland Management	Acre	1,800	3,600
Proper Grazing Use	Acre	750	1,500
Cooperative Forest Fire Control Program	Acre	4,270	4,270
Wildlife Habitat Management	Acre	30	225
STRUCTURAL MEASURES			
Diversion	Foot	10,000	500
Farm Pond	Number	100	30,000
Land Smoothing	Acre	100	1,500
Drainage Main or Lateral	Foot	26,000	10,400
Drainage Field Ditch	Foot	13,000	650
Terrace Gradient	Foot	5,000	250
TOTAL		XXXXXX	163,695

1/ Price Base: 1974.

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TABLE 2 - ESTIMATED STRUCTURAL COST DISTRIBUTION

Flat Rock Creek Watershed, Arkansas

(Dollars) 1/

Item	Installation Cost - Public Law 566 Funds					Installation Cost - Other Funds						Total Installation Cost
	Construction	Engineering	Land Rights	Relocation Payments	Total PL-566	Construction	Engineering	Land Rights	Relocation Payments	Archeological Salvage 7/	Total Other	
Structures:												
Multiple Purpose Structure Number 1	207,277	22,025	-	-	229,302	46,010	-	63,000 4/	-	-	109,010	338,312
Floodwater Retarding Structure Number 2	391,000	34,911	-	2,316	428,227	-	-	244,000 5/	684	47,000	291,684	719,911
Subtotal	598,277	56,936	-	2,316	657,529	46,010	-	307,000	684	47,000	400,694	1,058,223
Channel Work												
Channel Number 1 (M-4.2) 6/	2,179,016	194,555	-	-	2,373,571	-	-	386,200 2/	-	23,000	409,200	2,782,771
Channel Number 2 (M-3.2) 6/	15,070	1,345	-	-	16,415	-	-	10,200 3/	-	-	10,200	26,615
Subtotal	2,194,086	195,900	-	-	2,389,986	-	-	396,400	-	23,000	419,400	2,809,386
Project Administration	XXX	XXX	XXX	XXX	530,956	XXX	XXX	XXX	XXX	XXX	21,985	552,941
GRAND TOTAL	2,792,363	252,836	XXX	2,316	3,578,471	46,010	XXX	703,400	684	70,000	842,079	4,420,550

1/ Price Base: 1974
2/ Includes $210,000 for reconstruction and modification of two structures under Missouri-Pacific Railroad, $4,200 for relocation of sewer lines, $1,400 for relocation of power lines, $800 for relocation of water lines, $1,200 for relocation of gas lines, $11,000 for two buildings, $40,000 for fencing and $105,600 for road and bridge cost.
3/ Includes $10,000 for the installation of one bridge.
4/ Includes $20,000 for relocation of sewer line.
5/ Includes $10,500 for relocation of power lines and $20,000 for one building.
6/ Type of channel before project: (N) - An unmodified, well defined natural channel or stream; (M) - Manmade ditch or previously modified channel.
7/ Cost to be borne by National Park Service.

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TABLE 2A - COST ALLOCATION AND COST SHARING SUMMARY

Flat Rock Creek Watershed, Arkansas

(Dollars) 1/

Item	COST ALLOCATION			COST SHARING					
	PURPOSE			PUBLIC LAW 566			OTHER		
	Flood Prevention	Recreation	Total	Flood Prevention	Recreation	Total	Flood Prevention	Recreation	Total
Multiple Purpose Structure Number 1	215,403	122,909	338,312	175,291	54,011	229,302	40,112	68,898	109,010
Floodwater Retarding Structure Number 2	719,911	-	719,911	428,227	-	428,227	291,684	-	291,684
Channel Work	2,809,386	-	2,809,386	2,389,986	-	2,389,986	419,400	-	419,400
GRAND TOTAL	3,744,700	122,909	3,867,609	2,993,504	54,011	3,047,515	751,196	68,898	820,094

1/ Price Base: 1974

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TABLE 3 - STRUCTURAL DATA - STRUCTURES WITH PLANNED STORAGE CAPACITY

Flat Rock Creek Watershed, Arkansas

Item	Unit	Structure Number 1	Structure Number 2	Total
Class of Structure		c	c	XXXXXXX
Drainage Area	Sq. Mi.	0.36	5.17	5.53
Curve No. (1-day)(AMC II)		80	74	XXXXXXX
Elevation Top of Dam	Ft.	542.7	512.7	XXXXXXX
Elevation Crest Emergency Spillway	Ft.	537.7	504.5	XXXXXXX
Elevation Crest High Stage Inlet	Ft.	535.7	494.1	XXXXXXX
Elevation Crest Low Stage Inlet	Ft.	527.8	481.5	XXXXXXX
Elevation Crest Augmentation Inlet	Ft.	-	477.8	XXXXXXX
Maximum Height of Dam	Ft.	57	57	XXXXXXX
Volume of Fill	Cu. Yd.	115,210	298,230	413,440
Total Capacity 1/	Ac. Ft.	300	2,001	2,301
Sediment Submerged	Ac. Ft.	37	196	233
Sediment Aerated	Ac. Ft.	2	14	16
Recreation	Ac. Ft.	109	-	109
Retarding	Ac. Ft.	152	1,791	1,943
Between High and Low Stage	Ac. Ft.	115	225	XXXXXXX
Surface Area				
Sediment Pool 2/	Acre	(4)	31	31 3/
Recreation	Acre	11	-	11
Retarding Pool	Acre	20	145	165
Principal Spillway Design				
Rainfall Volume (areal)(1-day)	In.	9.1	9.1	XXXXXXX
Rainfall Volume (areal)(10-day)	In.	16.3	16.3	XXXXXXX
Runoff Volume (10-day)	In.	11.2	9.8	XXXXXXX
Capacity of Low Stage (Maximum)	cfs	26	67	XXXXXXX
Capacity of High Stage (Maximum)	cfs	123	180	XXXXXXX
Frequency Operation - Emergency Spillway	% chance	1	1	XXXXXXX
Dimensions of Conduit	In.	30	36	XXXXXXX
Emergency Spillway Design				
Rainfall Volume (ESH)(areal)	In.	12.5	12.5	XXXXXXX
Runoff Volume	In.	9.9	9.1	XXXXXXX
Type		Veg.	Veg.	XXXXXXX
Bottom Width	Ft.	50	350	XXXXXXX
Velocity of Flow (Ve)	Ft./Sec.	1.42	7.28	XXXXXXX
Slope of Exit Channel	Ft./Ft.	.022	.028	XXXXXXX
Maximum Water Surface Elevation	Ft.	538.0	506.9	XXXXXXX
Freeboard Design				
Rainfall Volume (FH) (areal) (6 hours)	In.	30.0	30.0	XXXXXXX
Runoff Volume (FH)	In.	27.2	26.2	XXXXXXX
Maximum Water Surface Elevation	Ft.	542.7	512.7	XXXXXXX
Capacity Equivalents				
Sediment Volume	In.	2.04	0.76	XXXXXXX
Retarding Volume	In.	8.00	6.48	XXXXXXX
Recreation Volume	In.	5.74	-	XXXXXXX

1/ Crest of Emergency Spillway.
2/ Area shown in () for reservoir with recreation storage.
3/ Total does not include area in ().

TABLE 3A - STRUCTURE DATA - CHANNELS

Flat Rock Creek Watershed, Arkansas

Channel Number	Station	Drainage Area	Capacity cfs Required	Capacity cfs Design	Water Surface Elevation	Hydraulic Gradient	Channel Dimensions 1/ Bottom	Depth	Side Slopes	Cross Sectional Area	Wetted Perimeter	"n" Value Aged	"n" Value As Built	Velocities Aged	Velocities As Built	Excavation	Type of Work 2/	Before Project Type of Channel 3/	Before Project Flow Conditions 4/
		(sq. mi.)			(ft. MSL)	(ft./ft.)	(ft.)	(ft.)		(sq. ft.)	(ft.)					(cu. yds.)			
1	70+00	0.99	949	949	417.8	.0010	20	5.3	Vert.	-	-	.012	.012	8.95	8.95		II_L	M(1947)	E
	82+25	1.01	949	949	416.3	.0010	20	5.3	Vert.	-	-	.012	.012	8.95	8.95		II_L	M(1947)	E
	93+00	1.01	1,265	1,265	405.8	.0011	22	5.8	Vert.	-	-	.012	.012	9.91	9.91		II_L	M(1947)	E
	112+00	1.52	1,416	1,416	402.0	.0010	22	6.4	Vert.	-	-	.012	.012	10.05	10.05		II_L	M(1947)	E
	122+00	1.53	1,416	1,416	401.9	.00054	24	7.4	Vert.	-	-	.012	.012	7.97	7.97		II_L	M(1947)	E
	132+40	1.99	1,526	1,526	401.8	.00036	26	8.4	Vert.	-	-	.012	.012	6.98	6.98		II_L	M(1947)	E
	136+50	2.18	1,526	1,526	401.6	.00030	28	8.4	Vert.	-	-	.012	.012	6.48	6.48		II_L	M(1947)	E
	149+50	2.69	1,526	1,526	401.4	.00025	30	8.4	Vert.	-	-	.012	.012	6.05	6.05		II_L	M(1947)	E
	161+00	2.69	1,526	1,526	399.6	.00025	30	8.4	Vert.	-	-	.012	.012	6.05	6.05		II_L	M(1947)	E
	236+91	3.18	1,056	1,150 5/	398.7	.0001	60	8.0	3:1	-	-	.030	.025	1.65	1.98		II	M(1947)	E
	292+41	3.62	1,122	1,122 6/	-	-	-	-	-	-	-	-	-	-	-	135,794	IV	M(1947)	E
2	203+16	15.11	740	1,360	402.3	.0034	-	-	-	159	64	.035	.035	4.65	4.65		IV	N	I
	257+16	15.60	780	1,513	392.9	.0014	-	-	-	184	42	.035	.035	4.24	4.24		IV	N	I
	293+83	17.00	850	850	389.6	.0002	-	-	-	380	56	.035	.035	2.23	2.23		IV	N	I
	328+83	19.15	976	958	388.9	.0005	-	-	-	321	57	.035	.035	3.05	3.05		IV	N	I
	353+50	19.84	1,011	1,448	387.4	.0009	-	-	-	274	56	.035	.035	3.68	3.68		IV	N	I
	373+50	20.12	1,046 7/	3,400	386.3	.0002	-	-	-	388	68	.035	.035	2.70	2.70	0	IV	N	I

1/ Where excavation is not planned, the cross sectional area and wetted perimeter below the hydraulic grade line are shown.
2/ II - Enlargement or realignment of existing channel or stream; II_L - Enlargement or realignment of existing channel or stream. (Subscript "L" represents impervious lining - concrete lined); IV - Clearing and removal of loose debris within channel section.
3/ N - unmodified, well-defined, natural channel or stream; M( ) - Manmade ditch or previously modified channel (approximate date of original major construction in parentheses).
4/ I - Intermittent-continuous flow through some seasons of the year but little or no flow through other seasons; E - Ephemeral - flows only during periods of surface runoff, otherwise dry.
5/ Design capacity provides 100-year protection.
6/ IBM - 650 water surface profile data shows that the channel below 236+91 is adequate with incidental debris removal.
7/ Design capacity is the 1-year routed peak discharge.

Total Length - 7.4 Miles

Total Excavation - 135,794 Cubic Yards

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TABLE 3B - STRUCTURAL DATA

GRADE STABILIZATION STRUCTURES

Flat Rock Creek Watershed, Arkansas

Channel Number and Station	Drainage Area (sq. mi.)	Design Capacity Principal Spillway (cfs)	Associated Frequency and Duration of Storm (% chance and hours)	Drop (feet)	Type of Structure
Channel Number 1					
Station 70+00	0.99	949	1% - 24 hours	3.4	SAF chute
Station 84+90	1.01	1265	1% - 24 hours	4.2	SAF chute
Station 96+25	1.52	1416	1% - 24 hours	6.3	SAF chute

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TABLE 4 - ANNUAL COST

Flat Rock Creek Watershed, Arkansas

(Dollars) 1/

Evaluation Unit	Amortization of Installation Cost 2/	Operation and Maintenance Cost	Total
Town Branch			
Multiple Purpose Structure Number 1 and Channel Number 1	183,990	800	184,790
Project Administration	27,700	XXX	27,700
Subtotal	211,690	800	212,490
Flat Rock Creek			
Floodwater Retarding Structure Number 2 and Channel Number 2	44,010	600	44,610
Project Administration	4,890	XXX	4,890
Subtotal	48,900	600	49,500
GRAND TOTAL	260,590	1,400	261,990

1/ Price Base: 1974
2/ 100 years @ 5 7/8 percent interest.

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TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS

Flat Rock Creek Watershed, Arkansas

(Dollars) 1/

Item	Estimated Average Annual Damage		
	Without Project	With Project	Reduction
Floodwater			
Crop and Pasture	20,740	5,430	15,310
Other Agricultural	300	80	220
Nonagricultural			
Residential	116,050	140	115,910
Commercial	6,300	0	6,300
Industrial	22,430	100	22,330
Subtotal	165,820	5,750	160,070
Indirect	23,460	870	22,590
TOTAL	189,280	6,620	182,660

1/ Price Base: Crop and Pasture Current Normalized Prices; all others 1974 prices.

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TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES

Flat Rock Creek Watershed, Arkansas

(Dollars) 1/

Evaluation Unit	AVERAGE ANNUAL BENEFITS									
	Flood Prevention				Nonagricultural Water Management				Average Annual Cost 3/	Benefit-Cost Ratio
	Damage Reduction	Intensified Land Use	Changed Land Use: Agricultural	Changed Land Use: Urban	Recreation	Secondary	Redevelopment	Total		
Town Branch										
Multiple Purpose Structure Number 1 and Channel Number 1	168,290	540	1,480	30,000	10,350	48,000	17,700	276,360	184,790	1.5 to 1
Project Administration	XXXXXXX	XXX	XXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXXX	27,700	XXXXXXXX
Sub-total	168,290	540	1,480	30,000	10,350	48,000	17,700	276,360	212,490	1.3 to 1
Flat Rock Creek										
Floodwater Retarding Structure Number 2 and Channel Number 2	12,540	4,140	4,000	36,000	-	24,870	7,000	88,550	44,610	2.0 to 1
Project Administration	XXXXXX	XXXXX	XXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXXX	4,890	XXXXXXXX
Sub-total	12,540	4,140	4,000	36,000	-	24,870	7,000	88,550	49,500	1.8 to 1
GRAND TOTAL	180,830 2/	4,680	5,480	66,000	10,350	72,870	24,700	364,910	261,990	1.4 to 1

1/ Price Base: Crop and pasture benefits current normalized prices; all other benefits 1974 prices.
2/ In addition, it is estimated that land treatment measures will provide flood damage reduction benefits of $1,830 annually.
3/ From table 4.

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INVESTIGATIONS AND ANALYSES

Land Treatment

The Conservation Needs Inventory for Crawford County provided information on land use by soil capability units. Information was also obtained from the Soil Conservation Service area and field offices concerning soils, capability units, and land use in the watershed. This information was used to develop the conservation needs for the watershed.

The quantity and cost of land treatment measures already applied were determined from field inspections, interviews with farm operators, and from field office records and personnel. The information was utilized in preparing Table 1A.

A systematic field survey showed ground cover, forest and hydrologic conditions, and treatment needs. This survey, supporting data, and information from other agencies and forestry officials served as a basis for the amount of remedial measures. The measures recommended will contribute to flood reduction and soil stabilization.

The conservation measures to be applied during the project installation period were determined on the basis of the need for treatment for watershed protection and flood prevention and the level of participation expected from landowners and operators. Consideration was also given to anticipated land use changes in the future, personnel available for technical assistance and planning, the ability of local landowners and operators to provide their share of funds, and experience gained from other projects.

Engineering

A base map of the watershed was prepared to show the watershed boundary, drainage pattern, system of roads, and other pertinent information.

Vertical controls were established from U. S. Coast and Geodetic Survey bench marks in the watershed and all surveys were referenced to mean sea level elevations.

Topographic information on the two sites was obtained by use of a telescopic alidade and a plane table. Maps with 4-foot contour intervals were prepared. Stage-storage and stage-surface area curves were developed using this information.

The heights of the dams and the sizes of the pools were determined by the storage volumes needed to contain the runoff from the design storm and to provide an additional storage for sediment. The principal spillways were determined by using the minimum pipe diameters recommended for

Class "c" structures. The emergency spillways were determined by flood routing the emergency spillway and freeboard storms. Sufficient detention storage is available to permit the use of vegetative emergency spillways.

The designs of the structures were based on procedures and criteria set out in Engineering Memorandum SCS-27 (Rev.) - "Earth Dams." In addition to the valley sections, additional channel cross sections were surveyed in the highly developed areas. Bridge and culvert cross sections were also taken.

Channel designs were based on procedures and criteria set out in Technical Release Number 25, Planning and Design of Open Channels. Channel Number 1 was designed to accommodate the flow from the 100-year peak discharge. Channel Number 2 was designed to accommodate the flow from the approximate 1-year peak discharge.

The lined channel was designed with the velocities in the subcritical range (S_o less than 0.7 S_c). This was accomplished by utilizing three grade control structures similar to SAF chute-type structures.

The design of the lined channel from Stations 161+00 to 96+14 was based on procedures and criteria set out in SCS Technical Release Number 15 with the associated ES charts. The Engineering and Watershed Planning Unit, Fort Worth, Texas made a model study and prepared the preliminary design for the remainder of the lined channel. This complex section includes expanding the bottom width to connect to multi-box culverts under U. S. Highway Number 64, determining the design hydraulics and capacity under a laundromat that is connected to the highway structure, and grade control structure below the laundromat.

A closed conduit was planned across the parking lot immediately above U. S. Highway Number 64.

The designed channel velocities of the earth channels which require improvement are considerably less than the velocities being experienced by some of the existing stable channels within the watershed.

Land rights maps showing the area needed for development were prepared for the sponsoring organizations.

A summary of physical data is shown in Tables 3 and 3A.

Hydraulic and Hydrologic

Basic Data Available

Rainfall records at Fort Smith, Arkansas, are available for the period of 1878 to the present. Runoff can be related to a gage on Cove Creek near Lee Creek, Crawford County, Arkansas.

Aerial photographs, watershed base maps, and quadrangle maps provided basic topographic information. Thirty-one valley sections showing topography, land use, and other pertinent data were surveyed to provide data for streamflow computations. Elevations were determined for all homes and businesses along Town Branch that were expected to flood.

Land use and cover conditions on agricultural land for both present and future conditions were estimated with the help of the district conservationist. Cover conditions on all woodland were determined by the U. S. Forest Service.

Soil cover complex which takes into consideration factors such as soils, relief, land use, and cover conditions were assembled in order to compute runoff curve numbers. These curve numbers were used in computing runoff for both present and with the land treatment measures installed.

Project Evaluation

Stage-discharge and stage-area inundated relationships were computed, as programmed on the IBM-650 computer. The computer uses the Doubt Method for backwater computations and valley width with reach length for area inundated computations. Water surface profiles through the bridges were computed using the contracted opening procedure similar to the method used by the Bureau of Public Roads and the U. S. Geological Survey. Water surface profile data for the lined channel were developed using the procedure in SCS Technical Release Number 15 with the associated ES charts. A model study was performed on the complex segment by the Fort Worth, Texas Engineering and Watershed Planning Unit.

Evaluation routings were made by a frequency method. Rainfall volumes of seven frequencies were taken from U. S. Weather Bureau Technical Paper 40 and two less-than-annual frequencies were determined from Technical Paper 40 data logarithmically extrapolated. Runoff volumes were determined by using runoff curve numbers. The Flat Rock Creek Unit was routed with present and three alternatives of structural measures. The Town Branch Unit was routed with present and two alternatives of structural measures. The stream reach routings were performed on the IBM-360 computer. The computer uses the coefficient routing method and the hydrographs were developed incrementally from a dimensionless hydrograph and a SCS one-day watershed evaluation storm cumulative rainfall table Type 1.

Area flooded was determined for each of the nine storms routed for each alternate. Depth of flooding in each of the homes and businesses in Van Buren was also determined for each storm for each alternate.

The water surface profile data was changed to allow for the effect of the channel work by modifying the computer output.

Structure Data

Both structures are equipped with two-stage risers. Structure Number 1 has a 70-csm first stage with a 340-csm second stage release rate set at the 100-year frequency. The first stage was determined by the available channel capacity downstream from the structure and the second stage was determined by full pipe flow. Structure Number 2 has an approximate 15-csm first stage with the second stage near 35-csm release rate, set at the 5-year frequency. These release rates allow for an approximate 10-day emptying time or less.

Floodwater detention storage was determined by routing principal spillway hydrographs. Rainfall data was taken from U. S. Weather Bureau Technical Papers 40 and 49. Routings were made as programmed on the IBM-1130 computer and were performed in accordance with criteria set out in Engineering Memorandum SCS-27.

Emergency spillway and freeboard hydrographs were computed and routed as programmed on the IBM-1130 computer which uses procedures outlined in Section 4 of the SCS National Engineering Handbook. The rainfall volumes were determined from maps included in Chapter 21 of Section 4 of the SCS National Engineering Handbook.

An orifice to discharge approximately .02 csm will be located in the riser of Structure Number 2 at the elevation of 477.8 feet mean sea level. The flow from this orifice will augment streamflow. The storage volume set aside for the second fifty years of sediment will be used to provide the supply for this orifice. The orifice will be located at the elevation of the first fifty years of sediment and the first stage will be located at the 100-year sediment elevation. The storage set aside will be adequate except during periods of extreme drought.

The design channel capacity for Town Branch was determined by routing the 100-year frequency peak discharge. The with project capacity of Flat Rock Creek is near the 1-year frequency peak discharge. Floodwater Retarding Structure Number 2 did not alone provide an acceptable level of protection making channel work necessary. Channel excavation would cause serious damage to the fish and wildlife habitat and channel erosion was possible. Channel clearing will significantly reduce the existing roughness and an acceptable level of protection can be reached without damaging the wildlife habitat or creating an erosive condition.

Geologic

Structures

A preliminary geologic investigation was made on both proposed damsites. This included studies of stratigraphy, rock structure, borrow materials,

and depths of overburden at the sites. These investigations were implemented by the use of portable seismic equipment.

Bedrock beneath Structures Numbers 1 and 2 is sandstone and shale of the Hartshorne Formation. Both damsites, which are underlain by competent bedrock at shallow depths, appear to have sufficient foundation strength for the proposed embankments.

The geologic structure of the area includes several anticlinal and synclinal folds in addition to the Mulberry Fault which traverses the central portion of the watershed in a northeast-southwest direction. Both damsites are situated north of the fault trace where several hundred feet of vertical displacement has occurred. The Fault is now dormant and should present no stability problems for the proposed embankments.

The emergency spillway of Structure Number 1 will contain a moderate amount of sandstone which will classify as rock excavation. This sandstone can be utilized in a rock toe in the downstream portion of the embankment. The emergency spillway of Structure Number 2 is not expected to contain any rock excavation.

Borrow materials occur in alluvial deposits. They are mostly GC and CL materials. Structure Number 1 will require approximately 11 acres of offsite borrow and Structure Number 2 will need about 18 acres of offsite material for the embankment.

Mineral resources in the Flat Rock Creek Watershed include deposits of sandstone, shale, gravel, sand, and natural gas. Large quantities of sandstone are found within the boundaries of the watershed and one large sandstone quarry is located in the north-central portion of the watershed. With reference to the above quarry, Bulletin 645, Mineral Resources and Industries of Arkansas, U. S. Department of the Interior, Bureau of Mines, 1969, states:

> Sandstone north of Van Buren in the SE 1/4 SE 1/4 of Section 8, Township 9 North, Range 31 West, has been quarried for about 10 years. Two beds in the Hartshorne Sandstone are utilized. The upper bed, averaging 12 feet thick, is a source of crushed stone for highway construction. A more resistant lower bed, 5 to 15 feet thick, is used for concrete aggregate and road-surfacing material. Sandstone production has been about 4.7 million tons and sandstone reserves are at least equal to total past production.

Mining of shale for roadstone is limited to small, isolated areas in the watershed. Extensive sand and gravel deposits occur in the bed of the Arkansas River near the outlet of Flat Rock Creek Watershed, but mining of sand and gravel in the watershed will be limited to small,

isolated deposits along Flat Rock Creek and its tributaries. Large quantities of natural gas reserves exist in the watershed. The nearest known producing gas wells to any planned structural measures are more than 2.5 miles from such structural measures and continued extraction from these wells is not expected to adversely affect the foundations of the structural measures. There are no known existing dry holes, mine openings, or other known pollution sources within the pool areas or drainage areas of Structures Number 1 and 2.

The data presented in the U. S. Geological Survey Water-Supply Paper 1969-L indicated that an abundant supply of shallow ground water is available in Arkansas River alluvium in the southern part of the watershed. The supply of this water is adequate for future needs. Groundwater resources are virtually undeveloped in the northern (upland) part of the watershed. The Hartshorne Sandstone is a potential source of ground water in the uplands but wells drilled in the strata probably would yield no more than 50 gpm. Ground water from the Arkansas River alluvium is mainly of the calcium-magnesium-bicarbonate type and is characterized by wide variations in the content of dissolved solids.

The range of concentrations (mg/l) of the principal constituents was iron (Fe), 0 to 21; bicarbonate (HCO_3), 95 to 622; sulfate (SO_4), 2 to 187; chloride (Cl), 2 to 164; nitrate (NO_3), 0 to 146; and calcium magnesium, 120 to 538. The specific conductance ranged from 234 to 1230 micromhos/cm at 25 degrees centigrade. Generally, ground water from the Arkansas River alluvium is suitable for domestic use; however, the iron and nitrate contents and the hardness may make the water undesirable for some industrial uses. Such ground water is rated as excellent to good and the rest as good to permissible for irrigation use.

Water quality in the proposed reservoirs is expected to be good. The drainage areas of the reservoirs have fair to good vegetative cover, the land use being predominantly woodland and pasture-range.

Channels

Studies of the earth channel sections indicate that stability from the standpoint of runoff flow will not be a problem. Both channels contain no appreciable bedload. Bedrock will not be encountered in any of the planned excavation. Channel bank and bottom materials on Channel Number 1 were sampled at thirteen locations and analyzed for size distribution and plasticity. The materials are nonplastic to slightly plastic with plasticity indexes ranging from 0 to 8, D75 sizes range from 0.175 mm to 0.54 mm. Of the thirteen samples, two are classified as ML, seven are SM, and four are SP.

Based on the permissible velocities procedure in Technical Release 25, the lowest computed allowable velocity of 2.0 feet per second will not be exceeded.

A changed condition in the ground-water table could present a stability problem during the construction of Channel Number 1. The problem is created by the elevated water table created by Lock and Dam 13 on the Arkansas River. Preliminary studies, investigations, and information supplied by the U. S. Corps of Engineers and U. S. Geological Survey indicate that the water table will be slightly above the elevation of the bottom of Channel Number 1. An estimate of the rate of return flow into the channel is 15 cfs. This volume of water is not significant but the SM and SP material which would have to be excavated will be completely saturated resulting in a possible bank stability problem; therefore, the depth of excavation on Channel Number 1 will be limited to an elevation of 392.0 feet, mean sea level, to minimize seepage from the Arkansas River. This revised design would allow the phreatic line of the water table to slope downward as it approached the channel and would intersect the channel at grade. Stability is not expected to be a problem once vegetation on the banks is established.

Sedimentation

Sediment sources were located and evaluated by field mapping methods. Soil cover complex and erosion studies were conducted on a representative portion of the upland area of the watershed. The basic erosion rate for each land use was determined from the detailed investigation. The present and future projected erosion and sedimentation rates were computed for Structures Numbers 1 and 2. Delivery ratios of damaging sediment from sheet erosion losses to the reservoirs are estimated to be 60 percent for Structure Number 1 and 42 percent for Structure Number 2. It is expected that the sediment yield from the watershed uplands will be reduced by 42 percent by land treatment and structural measures.

Watershed analyses indicate that average annual sediment concentration will be reduced by 44 percent by land treatment and structural measures. This will result in a reduction of about 200 mg/l from approximately 450 mg/l under present conditions to 250 mg/l for future conditions.

Hollis Lake which is located near the watershed outlet is currently receiving sediment at an annual rate of about 13.5 acre-feet. At this rate, the lake will be depleted by the year 2025. With the installation of planned land treatment and structural measures, Hollis Lake is expected to receive about 7.5 acre-feet of sediment per year after a 5-year installation period. Although the annual sedimentation rate will be increased during the installation period by channel construction, the decreased sedimentation during the remaining period will substantially reduce the total sediment accumulation. This reduction will prolong the life of Hollis Lake by approximately 40 years.

Economic

The benefited area was divided into two separate evaluation units which contained a total of five evaluation reaches for purposes of the economic analysis. These divisions were made because of the diversity of damageable values and the variation in physical characteristics of the flood plain. Reach I is the agricultural flood plain of Town Branch and Reach II is the urban area of Van Buren that is in the Town Branch flood plain. Reaches III, IV, and V include the benefited area of Flat Rock Creek which is predominantly agricultural. The reach locations are shown on the Project Map, Figure 4.

Damage schedules were obtained from the landowners and operators of about 30 percent of the agricultural flood plain in the watershed. The sample area was considered sufficient and representative for the evaluation.

These schedules provided historical information on flooding and flood damages as well as land use, rotation patterns, crop yields, production costs, and probable changes in land use. Land use and crop yield projections, as related to land resource areas and soil capability units, were obtained from river basin studies made by the Economic Research Service. These projections and the information in the field schedules were used to determine future "without project" conditions. The land use and yields in the watershed are actually present today or are based on the ERS projections for soils that are similar to those in the flood plain.

The frequency method was used throughout the analysis. Floodwater damages were computed for future "without project" conditions and future "with project" conditions. The difference in average annual damages before project installation and the damages remaining after project installation constitutes the damage reduction benefits.

Crop and pasture damages were evaluated as follows: The land use, yield, and current normalized prices were used to determine the damageable value per composite flood-plain acre. The damage rate per acre by depth increments and season of the year were obtained from factors that express damage for the respective depths and seasons as a percent of the value. The seasonal distribution of flooding was based on an analysis of historical rainfall records for Fort Smith, Arkansas, and the damages for selected frequency storms were computed from the acres flooded by depth increments and the corresponding damage per acre. The crop and pasture damages were converted to average annual equivalents and adjusted for recurrent flooding. The benefits from the reduction of crop and pasture damages included two effects: (1) reduction in area flooded, and (2) reduction in depth of flooding.

Crop and pasture damages were adjusted downward on the portion of the flood plain that will have a 100-year level of protection. This adjustment was made to account for the crop and pasture damages and benefits that will not

be realized due to rapid industrial development that is anticipated on this area following project installation.

Damage to other agricultural property, such as fences and livestock, was estimated for Reaches IV and V. This estimate was based on damage rates per acre used in the upper reaches of the Little Mulberry Creek Watershed which is located closeby and possesses physical characteristics that are very similar to this watershed. Other agricultural damages are insignificant in Reaches I, II, and III and were not analyzed.

Nonagricultural damages in the watershed consist of urban damages in the City of Van Buren caused by flooding from Town Branch. A detailed survey provided the location and elevation of each property within the 100-year flood zone. The value of each property was estimated for use in evaluating the damages. Interviews with the owners and occupants provided information on experienced floods, high water marks, and the damages which resulted. Damages were based on the depth of flooding and were calculated for several frequency storms.

The average annual urban damages were computed for the present state of development. It is estimated that normal improvements to the existing facilities, new development, and the increase in price and quantity of furnishings over time will result in higher values and damages in the future. The urban damages were adjusted upward based on projections of per capita income for Economic Area 08113, Fort Smith, Arkansas, made by the Office of Business Economics, U. S. Department of Commerce. These incomes were treated as an increasing annuity for forty years and as a constant annuity thereafter. A factor which expressed the present net effect of the income increase was applied to the "without project" and "with project" damage to reflect the gradual accrual of these values over time.

Benefits from the reduction of indirect damages were based on the direct damage reduction benefits. Indirect damages were estimated to be 15 percent of the urban damage and 10 percent of all other kinds of direct damage.

A portion of the damage reduction benefits was assigned to the land treatment measures included in the project. These benefits which amount to 1 percent of the total damage reduction benefits were not used for project justification.

Enhancement-type benefits expected to result from project installation were evaluated. The land use and crop yields, as projected by the Economic Research Service, and other available information indicate that changed and more intensive land use will occur on portions of the flood plain following project installation. The changed and intensified land use benefits represent the difference in net profits from farming operations between future "without project" and future "with project" conditions. The associated costs

were deducted and the increased damage to higher values was subtracted to arrive at the net benefit. The benefits were discounted for the appropriate lag in accrual.

Recreational benefits will accrue from the use of Multiple Purpose Structure Number 1. These benefits were based on a value of $1.00 for a visitor-day of use and an estimated 10,350 days of use annually. The visitor-days of use were estimated from secondary data and from field surveys in the local area. Factors that were considered in determining the visitor-days of use include the present population and trend, the area and facilities available for use, competitive recreational developments in the area, accessibility and convenience of the site, the capacity for sustained use, and the opportunities for different types of recreational use by seasons.

Redevelopment benefits will also accrue from the project as a result of providing employment opportunities for local labor in the construction and operation and maintenance of the project. The redevelopment benefits were based on 10 percent of the construction cost being expended for local labor. The redevelopment benefits from operation and maintenance of the project and from the basic labor required in the industrial development stimulated by the project were treated as a decreasing annuity for twenty years and appropriately discounted to obtain the present net worth.

Secondary benefits were analyzed to determine the effect of increased income and employment generated by the project. These benefits will be realized by landowners, workers, processors, and business establishments in the trade area. In the analysis, consideration was given to values added to several sectors of the local economy, as measured by economic multipliers.

The investment multiplier was used to measure the effects of (1) values added to agricultural inputs, (2) values added to transportation, processing and marketing, (3) values added to local retailers, and (4) the values added by additional employment. The values added to agricultural inputs were considered to be the difference in the farmer's cost for additional inputs and the wholesale value of those inputs. The values added to transportation, processing, and marketing were considered to be the difference in the value of the product as it leaves the local area and its value at the farm. The values added to local retailers are the amounts available for successive rounds of consumption spending.

The employment multiplier was used to measure the total effect of creating additional employment. The primary effect was treated as a redevelopment benefit, and the difference between the total and primary effect was considered to be a secondary benefit.

The employment multiplier was derived from the occupational classifications of the employed labor force. The ratio of the total employment to those employed in basic occupations was used as a basis for estimating the multiplier. The basic occupations included agriculture, forestry, fisheries,

manufacturing, and construction, exclusive of the construction employment used to determine redevelopment benefits. The basic data for estimating the employment multiplier were obtained from U. S. Census of Population, Arkansas, 1960, General Social and Economic Characteristics, Table 85.

The investment multiplier was based on data in the USDA Consumer Expenditure Survey Report Number 3, "Consumer Expenditures and Income, Rural Farm Population, Southern Region, 1961." The multiplier was estimated by summing the effects of successive rounds of spending and respending. The consumption expenditure for each of the successive rounds of spending and respending was based on the farm families' marginal propensity to consume.

The investment multiplier times the various sources of new income yields the total effect of the successive rounds of spending this new income. To estimate the net local effect of the project-induced investments and employment, both multipliers were adjusted to account for leakages. According to Wadsworth and Conrad, in a study of labor-surplus rural areas, it was concluded that because of leakage, only 12 percent of the newly created investment would be a local benefit. Hence, the investment multiplier was adjusted downward by 88 percent to account for nonlocal effects. The employment multiplier was adjusted to account for unused capacity. It was assumed for this analysis that labor would function at 90 percent efficiency.

The installation cost of the structural measures was converted to average annual equivalents by amortization for 100 years at 5 7/8 percent interest. Annual operation and maintenance costs were estimated and added to the annual installation cost to arrive at the total annual cost.
Areas that will be inundated by the flood pools were excluded from the damage appraisal. Production to be lost in these areas after installation of the project was compared with the appraised value of the sites. In this analysis, it was considered that there would be no production in the permanent pools. It was assumed that the land inundated by the flood pools would remain in the present use, woodland and grassland, under project conditions. The appraised value of the easement exceeded the value of production lost and the appraised value of the easement was used in project cost. The values used for land, easements, and rights-of-way were arrived at by using the market data approach.

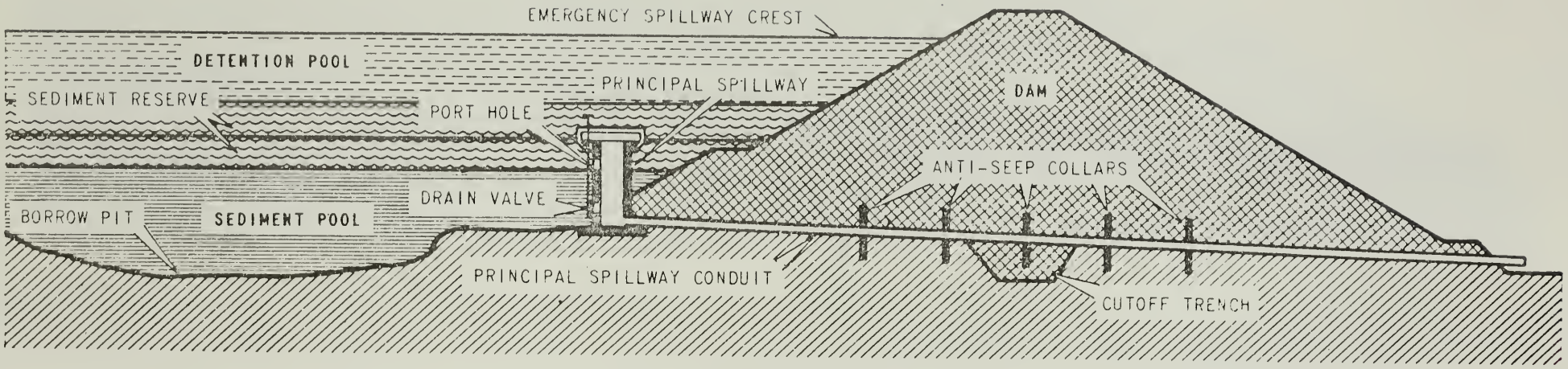


Figure 1

SECTION OF A TYPICAL FLOODWATER RETARDING STRUCTURE

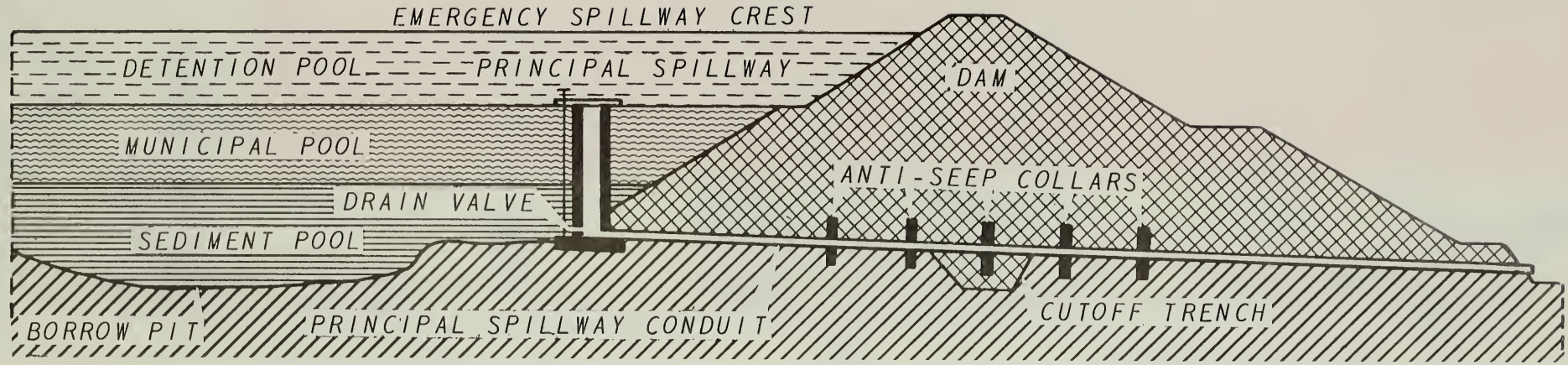
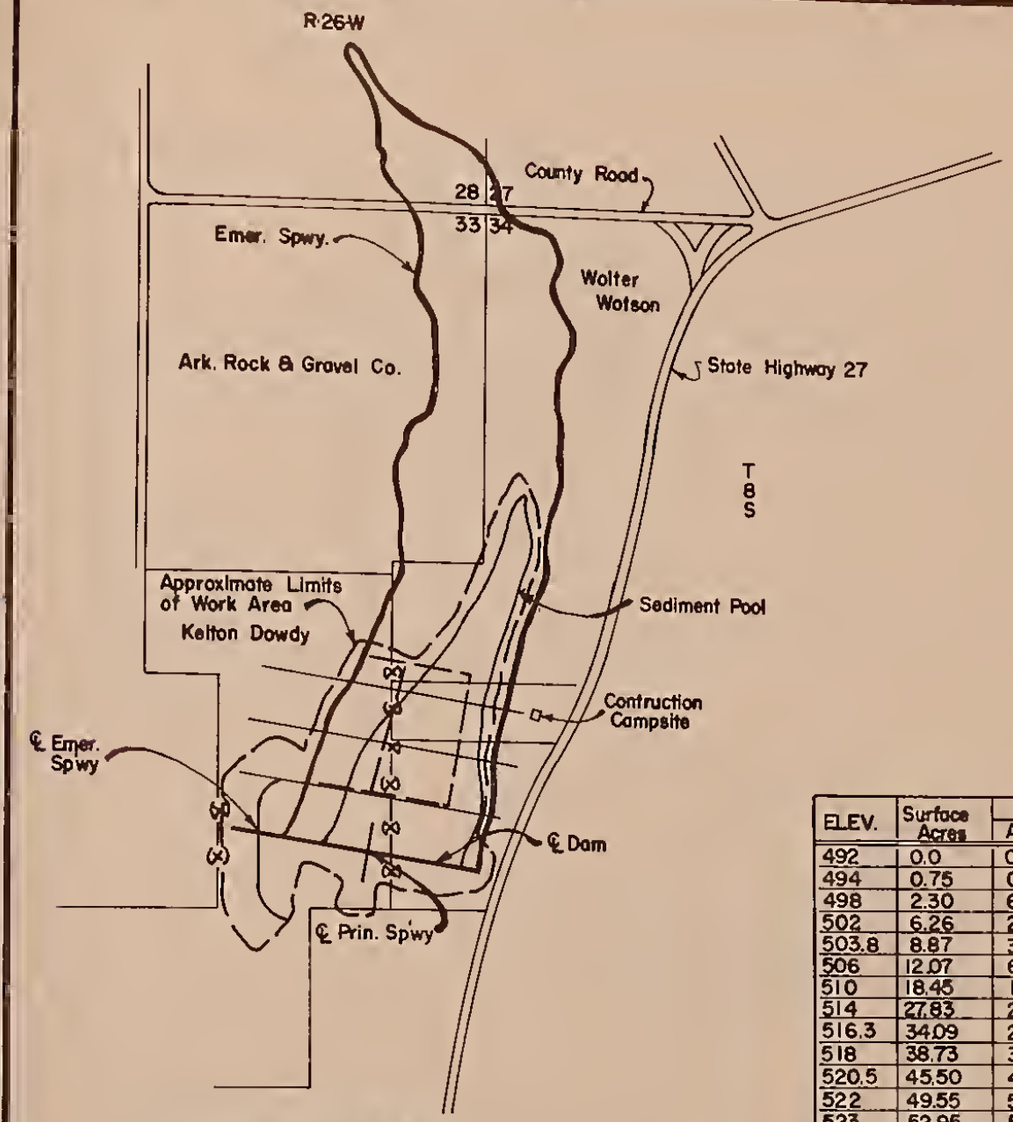


Figure 1A

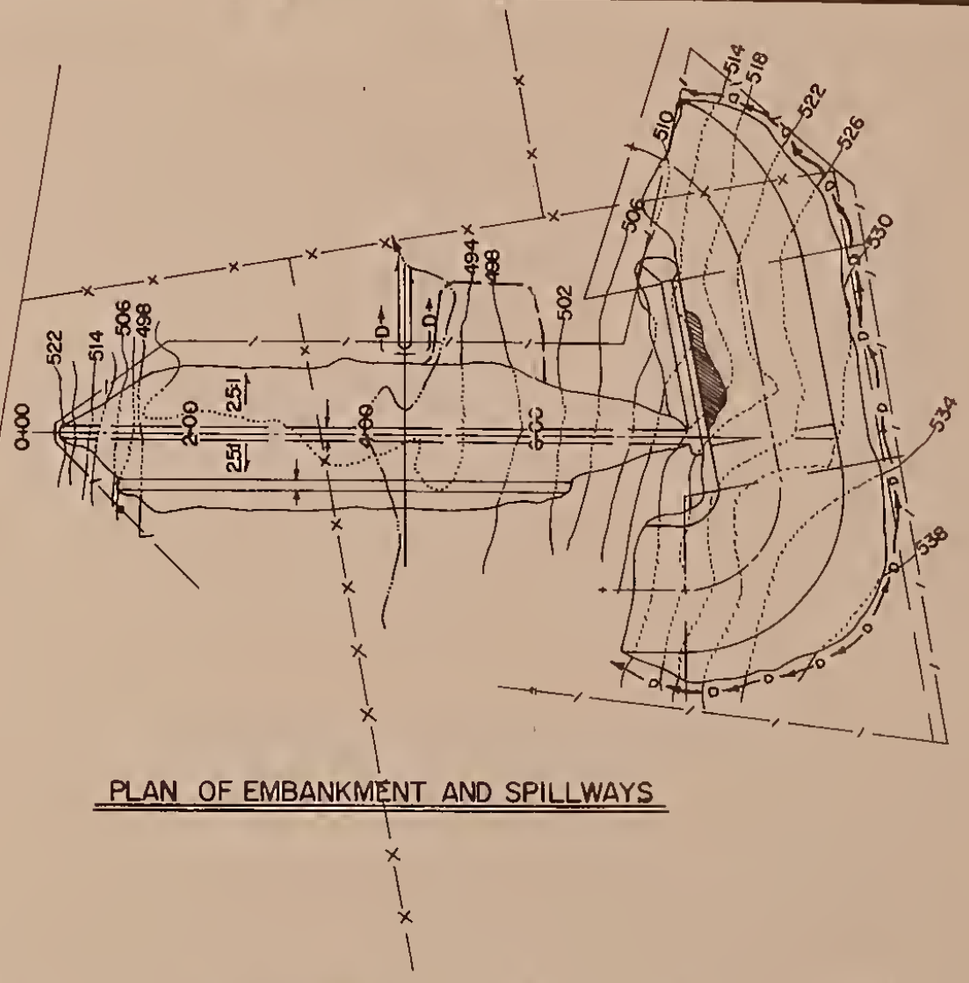
SECTION OF A TYPICAL MULTIPLE PURPOSE STRUCTURE



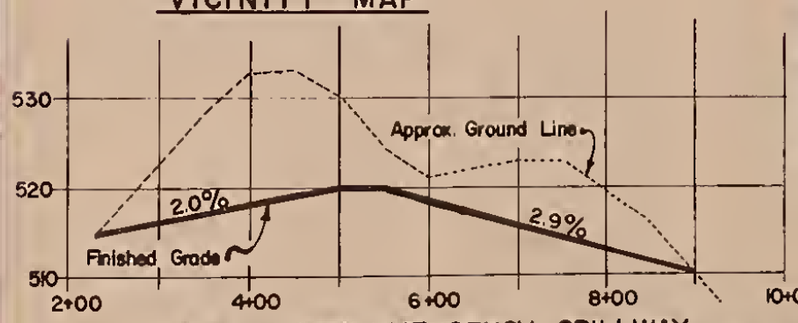
VICINITY MAP

ELEV.	Surface Acres	STORAGE AC-FT.	STORAGE INCHES
492	0.0	0.0	0.0
494	0.75	0.75	0.01
498	2.30	6.85	0.10
502	6.26	23.97	0.33
503.8	8.87	37.40	0.52
506	12.07	60.57	0.84
510	18.45	121.61	1.69
514	27.83	214.17	2.99
516.3	34.09	285.40	3.97
518	38.73	347.34	4.83
520.5	45.50	447.80	6.22
522	49.55	523.86	7.27
523	52.95	575.11	8.00
524	56.37	629.77	8.74

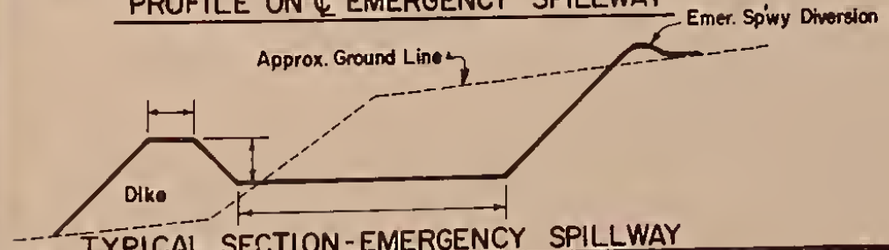
Top of Dam (effective) Elev.	523.5
Emergency Spwy Crest Elev.	520.5
Prin. Spwy Crest Elev.	516.3
Sed. Pool & Port Elev.	503.8
Drainage Area-Acres	864
Sed. Storage-Ac. Ft.	73.40
Floodwater Storage Ac. Ft.	374.4



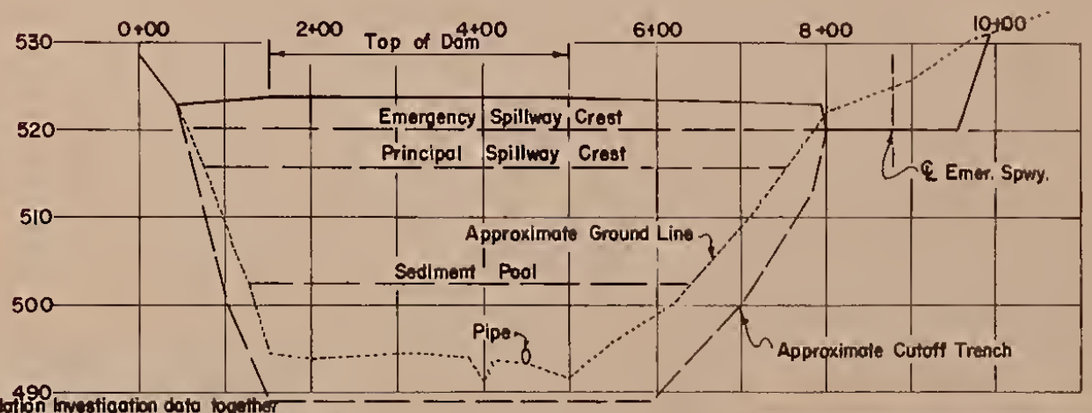
PLAN OF EMBANKMENT AND SPILLWAYS



PROFILE ON ℄ EMERGENCY SPILLWAY



TYPICAL SECTION-EMERGENCY SPILLWAY



PROFILE ON ℄ DAM

Additional soil and foundation investigation data together with laboratory test data are available in S.C.S. field construction office for review by prospective bidders.

Figure 2
TYPICAL
FLOODWATER RETARDING STRUCTURE
GENERAL PLAN AND PROFILE

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed
Drawn
Traced
Checked
Approved
Title Soil Conservation Engr.
Date
4-L-30711-1

4-30703

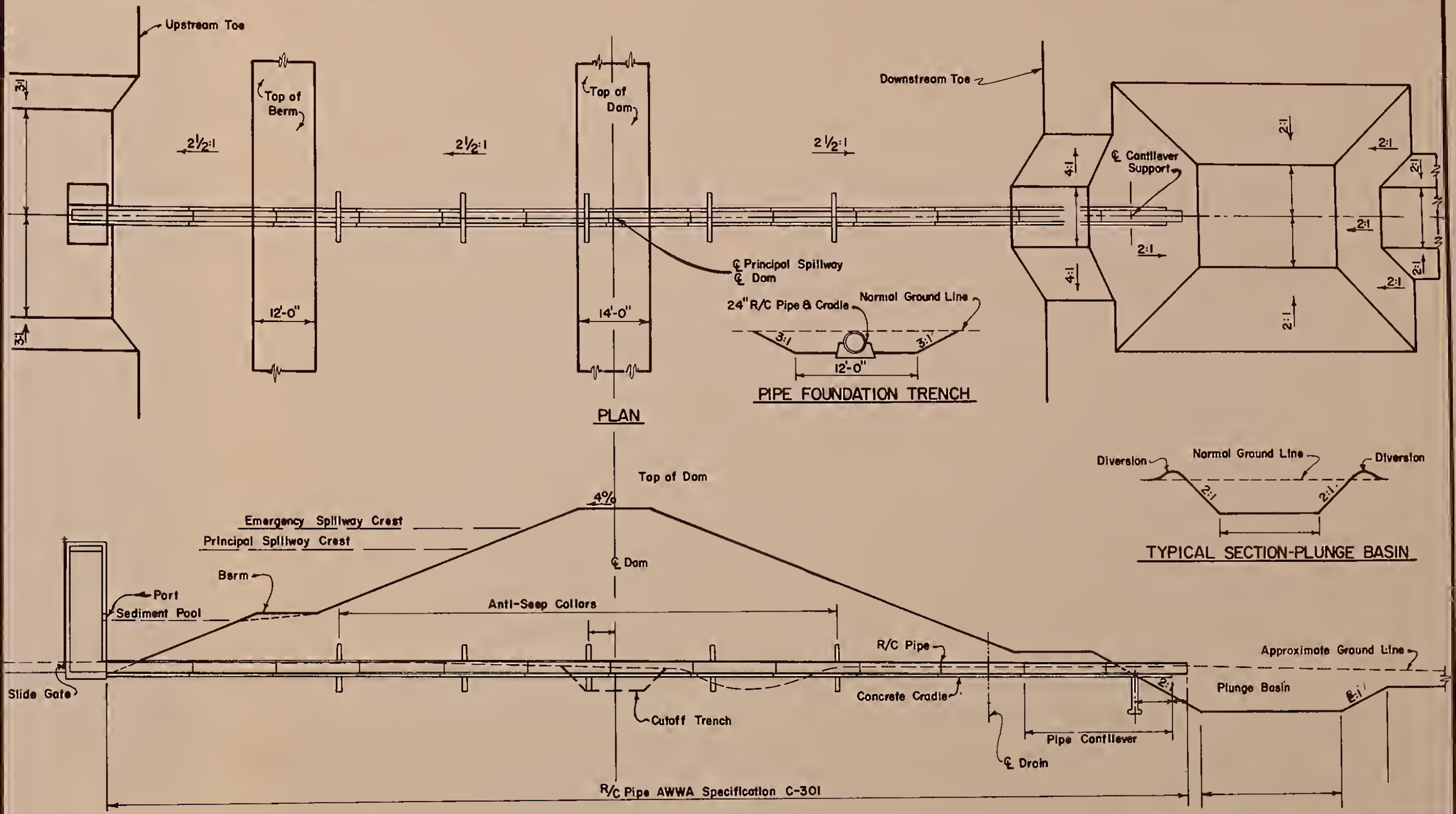


Figure 2a
TYPICAL
FLOODWATER RETARDING STRUCTURE
STRUCTURE PLAN AND SECTION

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Approved by: Lyle W. Bassett
Title: State Conservation Engr.
Date: 4-L-30711-2

4-30703

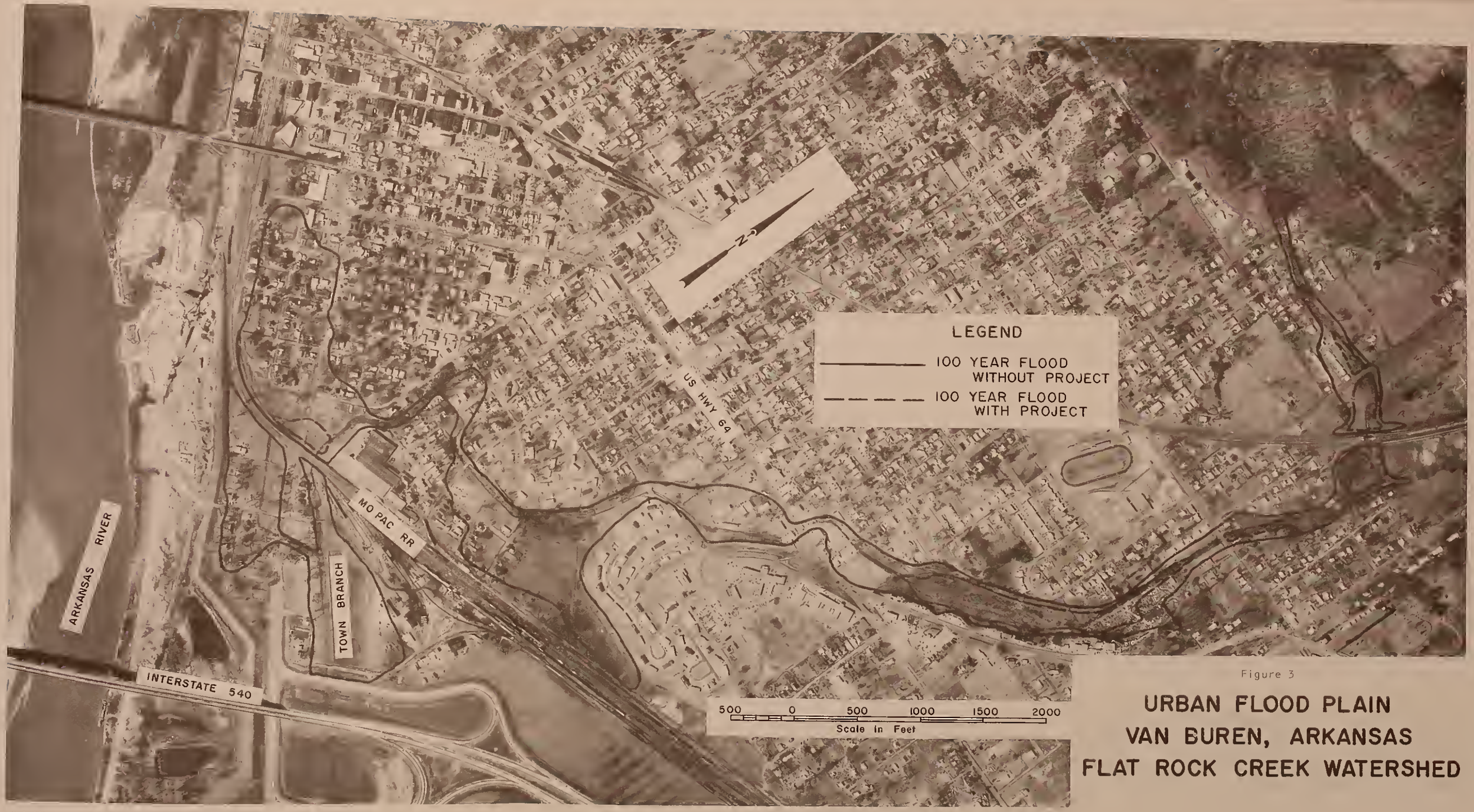


Figure 3

URBAN FLOOD PLAIN
VAN BUREN, ARKANSAS
FLAT ROCK CREEK WATERSHED

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, LITTLE ROCK, ARKANSAS
USDA-SCS-FORT WORTH, TEX. 1971

2-71 4-R-30,159

SITE NUMBERS AND DRAINAGE AREA IN ACRES

Site No.	Acres
1	230
2	3,309

R 32 W | R 31 W

94°20'

35°30'

35°25'

T 10 N
T 9 N

T 9 N
T 8 N

Furry

Shibley

ST. LOUIS & SAN FRANCISCO R.R.

PACIFIC R.R.

MISSOURI PACIFIC R.R.

MISSOURI

VAN BUREN

MISSOURI PACIFIC INDUSTRIAL PARK

HOLLIS LAKE

R-I

R-II

R-III

TOWN BRANCH

FLAT ROCK Reach

FLAT ROCK CREEK

Sta. 70+00

Sta. 203+16

Sta. 236+91

Sta. 292+41

Sta. 373+50

FLAT ROCK CREEK WATERSHED

ARKANSAS

ARKANSAS RIVER

LEGEND

- Interstate Highway
- U.S. Highway
- State Highway
- Low Type Road
- Gravel Road
- Unimproved Road
- Railroad
- City or Town
- Drainage
- Marsh
- Lake
- Dike
- Watershed Boundary
- Area Benefited
- Drainage Area Controlled by Structure
- Floodwater Retarding Structure
- Multiple Purpose Structure (R-Recreation)
- (1) Structure Number
- Sta. 203+16 Station Number
- R-I Evaluation Reach
- Channel Improvement For Flood Prevention
- Bridges to be Installed (Note: 7 Additional Bridges Within City Limits of Van Buren)
- Watershed Outlet

Figure 4

PROJECT MAP

FLAT ROCK CREEK WATERSHED

CRAWFORD COUNTY, ARKANSAS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
LITTLE ROCK, ARKANSAS

APPROX. SCALE 1 48,000

TOTAL D.A. 18,952 ACRES

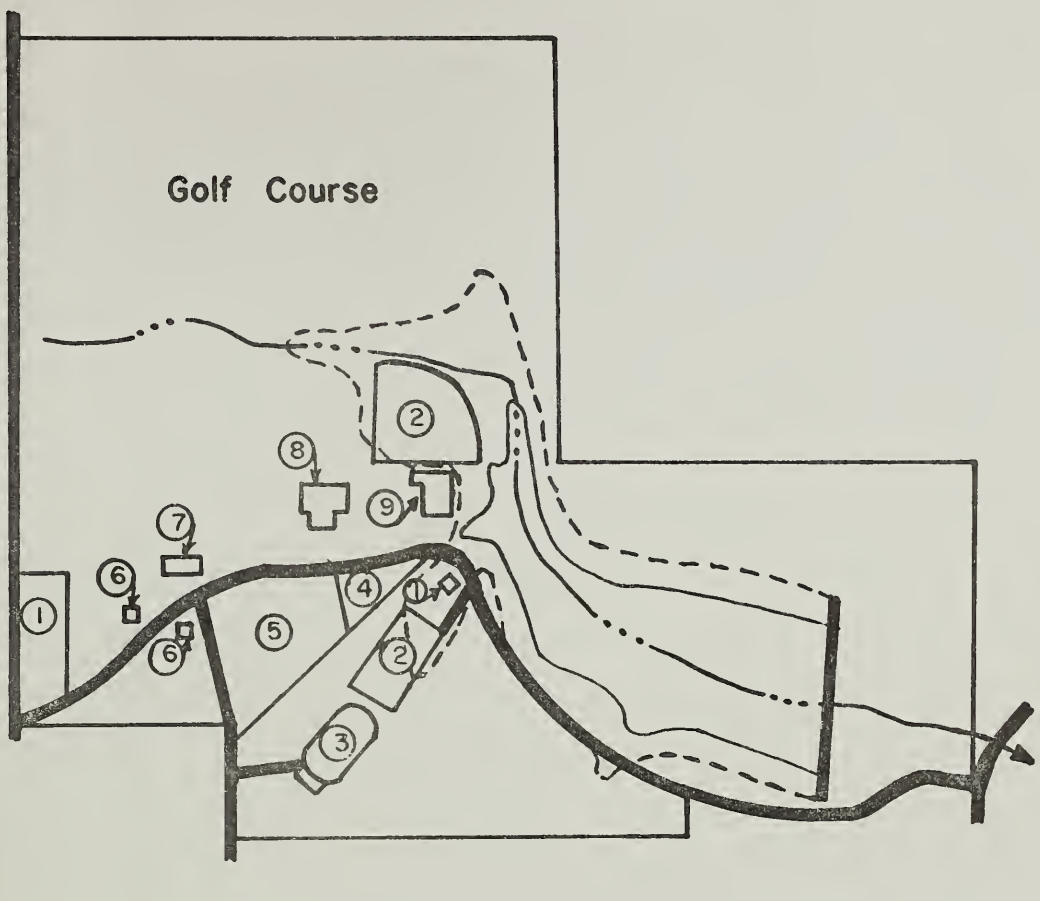
Base compiled from USGS quadrangle sheets and latest available General Highway Maps.

POLYCONIC PROJECTION

3-71 4-R-30189

Rev. 3-71 4-R-20,120

USDA SCS-FORT WORTH, TEX. 1971



LEGEND

Roads

Permanent Pool

Flood Pool

① Picnic Tables

② Ball Park

③ Rodeo Arena

④ Playground

⑤ Miniature Golf

⑥ Miniature Zoo

⑦ Country Club

⑧ Swimming Pool

⑨ Boys Club

FIGURE 5

CITY PARK

FLAT ROCK CREEK WATERSHED

VAN BUREN, ARKANSAS

0 660 1320

Scale-Feet